Proceedings

of the

Fifteenth

Indian Science Congress.

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Proceedings of the Fifteenth Indian Science Congress.

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The fifteenth meeting of the Indian Science Congress was held in Calcutta from January 2nd to the 7th, 1928. H. E. the Viceroy having been prevented from opening the Congress by illness, H. E. the Governor of Bengal welcomed the delegates in a short speech, after which the President, Dr. J. L. Simonsen, delivered his address

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The Sectional Presidential Addresses were delivered as follows :—

Tuesday, January 3rd, 10 A.M., Agriculture; 11 A.M., Botany; 12 noon, Mathematics and Physics.

Wednesday, January 4th, 10 A.M., Chemistry; 11 A.M., Zoology; 12 noon, Psychology.

Thursday, January 5th, 10 A.M., Geology; 11 A.M., Anthropology.

The following functions were arranged in connection with the Congress :—

January 2nd, 2 P.M. to 5-30 P.M., River trip on the Hooghly. The Local Committee "At Home" on board the steamer.

January 3rd, 2 P.M. to 4 P.M. Visits to following places :—

1. University of Calcutta.
2. Islamia College.
3. St. Xavier's College.
4. Asiatic Society of Bengal (3 P.M. to 5 P.M.).
5. Indian Museum.
6. Government School of Art (2-30 P.M. to 3-30 P.M.).

4-30 P.M. Garden Party by Sir R. N. Mookerjee at his residence, 7, Harington Street, Calcutta.

January 4th, 2 P.M to 4-30 P.M. Visits to :—

1. Presidency College Laboratories
2. Indian Association for the Advancement of Science, 210, Bow Bazaar Street, Calcutta.
3. An "At Home" by the Presidency College Physical Society to the members of the Physics Section.
4. Biological Laboratories of the University College of Science, 35, Ballygunj Circular Road, Calcutta.
5. Bose Institute, 93, Upper Circular Road, Calcutta.
6. University College of Science, 92, Upper Circular Road, Calcutta.

4-30 to 5-30 P.M. The Vice-Chancellor and Fellows of the University of Calcutta "At Home" (University College of Science, 92, Upper Circular Road).

8-15 P.M. Science Congress Dinner (Albert Hall).

January 5th, 3 P.M. to 5 P.M. Visits to:—

1. Bengal Engineering College, Sibpur.
2. Royal Botanic Gardens. (Light refreshments provided by the Staff.)
3. The Alipore Observatory and the Zoological Gardens.

An "Afternoon Party" at 5 P.M. by Bangiya Sahitya Parisad. (To all Full Members.)

An "At Home" by the Students and Staff of the Anthropological Department of the Calcutta University to the members of Anthropological Section of the Congress.

An "At Home" by Presidency College Chemical Society to the members of the Chemical Section of the Congress.

9 to 11 P.M. Musical Soiree (Albert Hall).

January 6th, 3 to 4-30 P.M. Visits to:—

1. Titaghur Paper Mills.
2. Jessop & Co.

4-30 to 6 P.M. Directors of the Bengal Chemical and Pharmaceutical Works. "At Home" to meet the members of the Congress.

4 P.M. The Department of Botany of the University College of Science. "At Home" to members of the Botany Section.

5 P.M. The Department of Zoology, the University College of Science. "At Home" to members of Zoological Section.

9-30 to 11 P.M. Reception at Government House.

January 7th, 3 to 4-30 P.M. Alternative visits to:—

1. Calcutta Broad-Casting Company.
2. Bengal Technical Institute.
3. Carmichael Medical College.

Whole day excursion to the Santiniketan at Bolepur. Dr. Rabindranath Tagore welcomed the members.

Public lectures were delivered as follows:—

January 3rd, "Radiations and their uses" by Prof. G. R. Paranjape, M.A., I.E.S. (Senate Hall).

January 4th, "Application of Chemistry in modern Warfare" by Prof. J. C. Ghosh, D.Sc. (Senate Hall).

January 5th, "Inheritance in plants and animals" by Prof. M.A. Sampathkumaran, M.A., Ph.D. (Senate Hall).

The Sectional Committees met on the 2nd January.

The Council met on the 4th January.

The Executive Committee met on the 4th January.

The General Committee met on the 5th January.

Opening Proceedings.

Before the opening of the Congress by His Excellency the Governor of Bengal, the President of the Congress, Dr. Simonsen, asked leave to communicate to the delegates a telegram from His Excellency the Viceroy, as follows :—

"YOUR EXCELLENCY, SIR RAJENDRA NATH MOOKERJEE, LADIES AND GENTLEMEN,

It is my duty in the first place to read to you a telegram from His Excellency the Viceroy whose absence from our midst to-day we so much deplore.

'I send to the members of the Indian Science Congress my best wishes for the success of their meeting. It is a matter of great regret to me that I should have been unable to attend the opening ceremony to which I was so much looking forward. Progress in the industrial world depends largely upon the action and interaction of pure science and the laboratory scientist on the one hand and the capitalist and the industrial worker on the other. We may justly congratulate ourselves on the close association between the scientists of the Indian Science Congress and the leaders of industry in India through the personality of Sir Rajendra Nath Mookerjee, Chairman of the Local Reception Committee of the Science Congress. I wish you one and all success in all your various undertakings.

(Sd.) VICEROY.'

With your permission I propose to send the following telegram in reply :—

'President and Members of the Indian Science Congress tender their grateful thanks for Your Excellency's stimulating message. They deeply regret Your Excellency's enforced absence from their opening meeting.'"

The proposal was accepted by acclamation.

The Chairman of the Local Reception Committee, Sir Rajendra Nath Mookerjee, then welcomed the Patron, His Excellency the Governor of Bengal, in a short speech and requested him to open the Congress, as follows :—

"YOUR EXCELLENCY,

It is my proud privilege to extend, on behalf of the Local Committee, a most cordial welcome to Your Excellency. The Indian Science Congress has been holding annual meetings for the last 14 years at various provincial centres and it has been our good fortune to count upon the patronage of the heads of the Provincial Government

on each occasion. We were expecting to be accorded the unique honour of the presence of both the Viceroy and the Governor at this session, but unfortunately owing to the serious illness of His Excellency Lord Irwin, who has been forbidden by the doctors not to participate in public functions for some time, we are unavoidably disappointed, but I am sure you will all wish to convey to His Excellency our respectful greetings and best wishes for an early convalescence.

Your Excellency, since you have come to Bengal you have endeared yourself to all classes of people by your active association with all movements that aim to promote knowledge and culture, and we welcome Your Excellency specially for your sympathy with the ideals which inspire the Indian Science Congress.

Science knows no politics; it works for the good of humanity. It knows no distinction of caste or creed and continues its dispassionate investigations and researches to unravel the mysteries of nature for the benefit of all mankind. This altruistic purpose has attracted to the shrine of science enthusiastic and keen workers seeking neither recognition nor honour but happy in the work they do and contented to advance knowledge a stage further. We in India are comparatively poor in the fruit ful application of scientific truths to practical questions, but it is nevertheless true that the solution of India's economic problems and the prosperity of its 300 millions depends entirely upon an increased power to produce wealth and this can be done only by the application of science to industry and agriculture.

The Indian Science Congress represents the visible embodiment of this spirit and we in Calcutta are grateful that they have chosen to meet in our city and so give a stimulus to the study of scientific knowledge. Your Excellency's presence here will give an added encouragement to the efforts to increase the spread of science, and on behalf of the Local Committee I beg to express our grateful feelings of appreciation for Your Excellency's presence and patronage. I have the honour now to request Your Excellency to open the Session."

His Excellency the Governor of Bengal, as Patron of the Congress then addressed the meeting as follows:—

"MR. PRESIDENT, SIR RAJENDRA, LADIES AND GENTLEMEN,

I find myself in the position in which I am this morning, owing to the unavoidable absence of His Excellency the Viceroy through illness. In the ordinary course it would have been my privilege, as Chancellor of this

University of Calcutta, to welcome the Viceroy to open this Congress, but in the absence of His Excellency, this duty has fallen upon me, and as Governor of this Presidency and also as Chancellor of the University, I beg to offer a hearty welcome to the Indian Science Congress to Calcutta. It will be a matter of regret that His Excellency is unable to be with us to-day. I know he is personally very disappointed, as no one appreciates more than he the value of scientific research to the progress and prosperity of India, and you can depend upon every encouragement from him.

This is the third occasion upon which the Congress has met in this city, since your Association was founded in 1912. On the two previous occasions it was presided over, in 1914, by Sir Asutosh Mukharji, one of the most eminent educationists that India has produced, and, in 1921; by Sir Rajendra Nath Mookerjee, who has gained by his sterling qualities a position not only of one of the most prominent citizens of this city, but has also made a name which is held in the highest respect throughout British India and, indeed, the Empire. One of the first sponsors of the Congress was Dr. J. L. Simonsen and it is most fitting that he should preside over this the third Session in Calcutta. I understand he has come from England for this express purpose, and this proves his devotion to your interests.

The Association of the Congress has always been closely associated with the University of Calcutta. The names of Sir P. C. Roy and Sir J. C. Bose appear amongst the list of past Presidents, which shows the intimate relationship of Calcutta with your Association. In this connection I may also be allowed to mention the names of Professor Raman and Dr. Saha.

Upon the work of Scientists depends, to a great extent, the solution of those problems which lead to the material and moral welfare of the peoples of the world. The progress of present-day civilization owes much to the devolopment of scientific research amongst the peoples of the West, and I trust that in the course of time, through your endeavours, the scientific spirit will help to revivify the ancient civilization of this country.

For the votaries of science the paramount consideration is the investigation of the secrets of Nature and their utilization for the benefit of humanity.

In the work of unlocking the secrets of Nature, you are taught by tradition and training to bring to bear on the problems before you a mind free from bias, prejudice and pre-conceived ideas. Facts are observed, investigated, catalogued, correlated and classified by you, and when proved beyond question, they form the basis upon which

you raise your structure of the conception of the phenomenal world. The history of science reveals the clash between the impersonal attitude of the scientific mind and the pre-conceived notions of the age, to which belonged privileged votaries of science, who devoted themselves to win the victory for truth and reason. Their struggles and sacrifices have not been in vain, as the results of the triumph of science are patent to the whole world.

Science has gradually achieved the freedom of the human mind from the domination of superstition and unquestioning belief. What was thought impossible in the past, and supernatural, has now become fact of everyday experience. I think I am right in saying that during the last quarter of a century the products of scientific research and investigation have been little short of phenomenal. Science in the West is over two centuries old in the lands of its origin. In India, you are marching along, learning from the West and in some subjects teaching the West. In Physics, the standard has reached a high level, which has been duly recognized by numbers of Indian scientists being awarded Fellowships of the Royal Society and other rare distinctions. With the spread of the spirit of Science, old barriers will be obliterated and it should bring about a silent revolution in the amenities of everyday life. As the public gradually appreciate the claims of science on their support, and the number of men trained in scientific methods increases, and they are given an outlet for organized team work, one may picture India fully utilizing for the benefit of humanity its intellectual and material resources. This hope can only be realized by the encouragement of organized research by leaders of industry and a generous public. As India advances in the domain of science, the contributions of Indians to the progress of scientific knowledge and the development of industrial processes should proceed together. We witness to-day signs that a good beginning has been made, and that India is coming forward with her contributions to the progress of science. This University is proud to be so intimately connected with your Association. The fact that the Congress is being held within the precints of the University should provide encouragement and inspiration for those who are now endeavouring to fit themselves for a career in which scientific knowledge is paramount.

I take this opportunity of wishing your Congress all success and trust that the result of your deliberations may prove beneficial to the people of India. I regret that pressure of work will not permit of my staying to hear the address of Dr. Simonsen. I am very conscious that I am missing an education in science which I badly need, but

I feel sure that Dr. Simonsen will understand that it is only pressing engagements that cause me to leave this Hall, and I must content myself with the pleasure of reading the speech when delivered.

Ladies and gentlemen, I have much pleasure in declaring the Congress open."

After the opening of the Congress, the President on behalf of the Congress thanked His Excellency for his kind welcome in the following words :—

"It is my privilege on behalf of the members of the Indian Science Congress to thank Your Excellency for the kind welcome which you have given us. As you have already mentioned, Sir, this is our third visit to Calcutta in itself a sufficient testimony to our appreciation of the hospitality of this great city.

Although Calcutta is no longer the official capital of India, with the great learned society, the Asiatic Society of Bengal, under whose auspices we meet and with the numerous and well equipped laboratories, there can, I am sure, be no question that Calcutta still remains the scientific capital.

May I once more tender to you our grateful thanks for your presence here to-day and for your welcome ?"

After these words of thanks His Excellency left the meeting accompanied to the exit by the Chairman of the Reception Committee.

The President then delivered his Presidential Address.

Presidential Address.

Congress President :—J. L. SIMONSEN, ESQ., D.Sc., F.I.C., F.A.S.B.

"There are two ways of knowing : namely by statement (argumentation) and by experiment. A statement lays down, and makes us define the scope of a problem ; but it neither confirms doubt nor removes it in such a way as to give one trust in the attainment of certitude, unless it arrives at the truth by way of experiment." (*Roger Bacon.*)

To the office which I have the honour to fill to-day my distinguished predecessors were appointed as a testimony of their eminence in some branch of scientific research. This was the highest distinction which the Congress could confer upon them. I do not flatter myself that I have been elected your President because of the value of my direct contributions to the advancement of science but rather as a reward for the work which it was my privilege to perform during the early years of the Indian Science Congress, when, with the active assistance of numerous colleagues, I served as your secretary. Perhaps for that reason I value the honour the more since I cannot but regard the Congress somewhat in the light of that in which a fond parent regards a favourite son.

It is with profound regret that I have to record the death of Sir Ganga Ram, a distinguished engineer and agriculturist. Sir Ganga Ram was elected President of the Section of Agriculture in 1922, but was prevented by ill-health from being present. His deep interest in the Congress was shown last year by his munificent gift to the University of the Punjab when he endowed a scholarship in commemoration of our meeting in Lahore. He died in London as a member of the Royal Commission on Agriculture helping to the end a cause which he had deeply at heart. He died in harness as he himself would have desired.

As the theme of the first portion of my address I propose to give an account of the early history of the Congress. I think it is desirable that an authoritative statement should be on record since in a few years our knowledge of this may be lost. In order that you may be able to appreciate the causes which led to its formation it is necessary we should try to visualise the position of scientific research in India in 1910-1911.

Early in the present century it was recognised by those in authority that all was not well with university education in India, and in 1904 what may be called the Curzon Commission on University Education was appointed. As a result of the re

commendations of this Commission, it was decided to raise the standard in the various universities and to introduce what are generally known as honours courses. At that time direct teaching was not undertaken by the universities which were solely examining bodies, the actual instruction being given in the affiliated colleges. To bring into effect the new courses it was necessary to increase the teaching staffs in the various colleges, and it is clear that this Commission realised the desirability of stimulating research in the University Colleges. They recognised the correctness of the view, so concisely expressed by Dr. Alexander Hill, " Where there is no zeal for research there is no vitality in teaching." If we except three great names in the history of scientific research in Indian Universities, I refer to our three past presidents, Sir Alfred Bourne, Sir Jagadis Bose and Sir Prafulla Ray, I do not think that I am wrong in saying that research in the universities at the commencement of the century was practically non-existent. I do not wish to infer that scientific research in India was non-existent at that date. This was very far from being the case, but research was confined to the various scientific services such as the Survey of India, the Geological Survey, the Botanical Survey, and the Meteorological and Agricultural Departments to mention only a few. From all these departments work of the very first importance emanated, and it is only necessary for me to mention the names of Sir Ronald Ross, Sir Leonard Rogers, Sir Sydney Burrard, Sir Thomas Holland, and Sir Gilbert Walker.

It was under these somewhat uninspiring circumstances that in 1910 Professor MacMahon and I found ourselves when we were appointed to the newly created chairs of chemistry in the Canning College, Lucknow, and the Presidency College, Madras. Coming as we did from large English laboratories, we at once felt the great lack of any scientific intercourse. Not only was there neither in Lucknow or Madras any scientific society, but in addition there was a complete absence of any scientific atmosphere. At that time, if we except the meetings of the Asiatic Society of Bengal, the only opportunities afforded for scientific discussion were the somewhat irregular conferences promoted by the Government of India such as—Sanitary Conferences or Conferences of Agricultural Chemists. These were purely official gatherings, and it occurred to Professor MacMahon and myself that scientific research might be stimulated if an annual meeting of workers somewhat on the lines of the British Association could be arranged. We felt that not only would the direct personal contact and association of actual workers be of great value, but also that the general public would be brought to realise the importance and value of scientific research. We decided therefore to obtain the views of other scientists, and in the autumn of 1911 we issued a circular letter which is reproduced as Appendix I to this address.

Whilst the general concensus of opinion was favourable to our proposal to have an annual meeting, the doubt was expressed by many of those best able to judge whether the time was ripe for such an organisation. Some considered that there was not sufficient work being done in India to justify an annual meeting, whilst others suggested that, in view of the great distances, it would prove impracticable to arrange for such meetings.

We decided to proceed with our proposal, and in 1912 we selected seventeen of the foremost men of science to act as a committee to arrange for the holding of the first annual meeting. (Appendix II.) On Saturday, 2nd November, 1912, a conference was held in the rooms of the Asiatic Society of Bengal with the late Sir Henry Hayden in the chair. The others present were Messrs. Christie, Hooper, Kemp, Tompkins, MacMahon and myself. The actual minutes of the meeting are reproduced in Appendix III, the most important resolution reading as follows : " The Asiatic Society of Bengal be asked to undertake the management of a Science Congress to be held annually."

As you are all aware progress in India is always slow, and although it had been our intention to have the first meeting in Calcutta in December, 1912 or January, 1913 this was not feasible and it was not until the 17th January, 1914 that the first meeting was held with the late Sir Asutosh Mukherjee as President. The delay was perhaps not altogether unfortunate since our first meeting thus coincided with the centenary celebrations of the Indian Museum. The actual meeting extended over three days and the number of papers notified for reading were thirty-one.

Whilst the number of papers which were presented to the first meeting and the attendance thereat appeared to augur well for the future, yet an examination of the authorship of the papers showed that of the thirty-one no fewer than twenty-five were from authors resident in Calcutta or other places in Bengal. This lent support to the attitude of those critics of the scheme who suggested that distance would prevent the holding of successful annual meetings, and it had also to be borne in mind that Calcutta then, as now, was the centre of scientific research. It appeared to us therefore that, if future meetings were to be successful, some form of government recognition was necessary so that Local Governments might be induced to pay travelling allowances to government servants. We therefore approached a body which is now defunct, the Board of Scientific Advice, which comprised the heads of the various scientific services and we were fortunate in obtaining the enthusiastic support of two members of the Board, Sir Sydney Burrard and Sir Henry Hayden. As a result of their representations the Government of India authorised Local Governments to permit such officers, as they might consider desirable, to attend our meetings. Not

content with this Sir Sydney Burrard also induced the majority of the Indian Railway Companies to grant concession rates to non-government servants who wished to attend. Unfortunately owing to the war this concession was withdrawn and in spite of repeated representations the railway authorities appear to be unable to recognise the importance of our meetings and this concession has not since been renewed. I sincerely hope that in future wiser counsels may prevail.

I feel that I should be wanting in gratitude if, before leaving this aspect of the subject, I did not take the opportunity of placing on record my great appreciation of the help and encouragement which we received in the early days from Sir Sydney Burrard and Sir Henry Hayden. The former was our President at Lucknow in 1916 and those of us who were present on that occasion will still remember his brilliant Presidential Address; it was not our fortune to have Sir Henry Hayden in this office but I betray no secrets when I say that it was not because it was not offered to him. With that modesty so characteristic of him, he preferred to work behind the scenes and his help was never asked in vain.

It is not necessary for me to refer in detail to our later meetings. Each year has shown a growth in the number of our members and in the number of papers contributed. It is now becoming one of our most pressing problems to know how best to deal with these papers.

May I be permitted here to digress for a moment? Without desiring to minimise the importance of the reading of papers and the discussions arising therefrom, to me the great value of our meetings has seemed to lie in the personal contact outside the lecture room. To our younger members it cannot but be an inspiration to meet and talk to the leaders of scientific thought in India. This aspect is in my opinion all too frequently lost sight of and I wish to take this opportunity of emphasising it.

The secretarial work of the Congress continued to be shared by Professor MacMahon and myself until 1921 although during the greater part of this time Professor MacMahon was absent from India on active service in France. In April, 1921, Professor MacMahon resigned and his place was taken by Professor Raman who had from the start been an active supporter. When in 1924 pressure of other work compelled Professor Raman to resign, your present senior secretary, Professor Agharkar, was appointed. To them we owe a debt which will be difficult to repay.

No account of the history of the Congress would be complete without a reference to our relations with the Asiatic Society of Bengal. I have frequently been asked to explain our relationship and I have always found it somewhat difficult to do so. In the minutes of the original committee meeting it is recorded that

the Asiatic Society of Bengal were to be asked to arrange the first Congress and this they did. In subsequent years the bonds attaching us to the Society were extremely close but there was no definite connection beyond the fact that the Honorary Treasurer and Secretary of the Society were *ex-officio* members of the Executive Committee whilst at first the appointment of the Congress Secretaries required the confirmation of the Society's Council. This loose unwritten constitution has proved to be all to the advantage of the Congress. The Society has acted as our Treasurer, it has met a large part of the cost of our publications and has undertaken much of our routine secretarial work. I think that we are deeply indebted to the Council of the Society for permitting their officials to assist us in this manner and more especially to their General Secretary, Mr. van Manen. So far as I can see the Society has not had any direct benefit from the connection whilst to us it has been of incalculable value. On financial grounds alone I do not think that without their aid we could have survived. I trust that the unwritten law which binds us to the Asiatic Society of Bengal may continue, since, to be associated with an ancient society of such standing, cannot but add lustre to our name.

It has been my privilege for nearly eighteen years to have been closely connected with education and research and this seems to me to be an opportune time to consider how we now stand as compared with 1910 when the idea of the Congress was conceived. In 1910 as I have already mentioned research was confined mainly to the various scientific services, in other words it was almost entirely carried out by Government servants. The condition was therefore completely different to that prevailing in Great Britain where such participation was practically unknown. As one of the results of the great upheaval due to the War the position in Great Britain has undergone a fundamental change. The activities of the Department of Scientific and Industrial Research are so well known that I need only refer to them in passing, whilst in addition, the British Government has further recognised the fundamental importance of research by the appointment of the Civil Research Committee, which may be regarded as Scientific Imperial General Staff.

During the latter years of the War and for a short time afterwards it appeared that the Government of India had at length come to recognise that it should do all that lay within its power to organise and encourage research. I am much afraid that this hope was illusory and that the impetus was due mainly to Sir Thomas Holland. With the departure from India of this great scientist and administrator not only did advance cease but a retrograde reaction seemed to set in. Perhaps the most serious and direct blow was the curtailment of the grant to the Indian Medical Research Fund Association.

Fortunately, this grant has once more been restored but it will be many years before the trained workers who were lost can be replaced. On the other hand, it is with pleasure that we note an advancement in a direction new to India, namely, the formation of the research associations for the investigation of cotton and lac. The work of the Indian Cotton Committee, with which our past President, Mr. Howard has been so intimately connected, is too well known to require elaboration, whilst the Lac Research Association has made a successful start. I have referred to these two research bodies as I consider that research conducted on these lines by independent organisations is to be encouraged in every manner possible.

Whatever may prove to be the future line of development of research in India, there can be no question that both the Imperial and Provincial Governments must continue to be deeply interested and involved. Unfortunately, the present organisation suffers from a grave disability in dealing with any scientific problem in that it no longer possesses an advisory body to whom it can refer such problems. Open as the former Board of Scientific Advice was to criticism I would strongly commend to the authorities its reconstitution on a broader basis. There can be no question that Governments require an influential and impartial body to whom they can refer matters of scientific importance. The expense involved would be small, and the advantages to be gained are obvious.

Whilst the advance of the spirit of research in the universities can be viewed with satisfaction, I do not think that those of us who have been intimately connected with teaching for the past twenty years can look with equal satisfaction on the present position of Indian Universities so far as the general academic standing is concerned. A large number of new universities have been created and on paper the courses of study and the standard of examination would appear to be the equal of those obtaining in other countries. In actual fact this is far from being the case and it is with a due sense of responsibility that I feel compelled to say that, with few exceptions, the degree standard has been considerably lowered during the last few years. In my opinion the blame does not lie with those actually engaged in teaching. The recent University Acts have placed far too much power in the hands of laymen. No doubt a patient is fully aware of the qualities which he expects to find in the medical man who attends him; the contractor knows what he requires of the engineer whom he employs. This does not however justify either the patient or the contractor in thinking that he knows the correct courses of study or the correct standard of examination which will enable him to obtain the doctor or engineer he desires. Yet, if we examine the constitution of the majority of the Indian Universities we find that, owing to a desire for democratic control, the real power

has been taken out of the hands of the professorial staff. I am willing to grant that it is highly desirable that the general policy of the university should be regulated by laymen, but I would emphasise the necessity of debarring them from any detailed control of either courses of study or the standards of examination. These should be absolutely under the control of the professorial staff and it should be impossible for the administrative body of the university to order that the percentage number of passes in any examination should be increased as has to my knowledge happened more than once. The only result is a general diminution in the status of the degree and if this is permitted to continue the degree of an Indian University will cease to be of value in academic and industrial affairs. Perhaps we shall see a change when there is a clearer realisation of the difference between knowledge and wisdom. It was Cowper who wrote

> "Knowledge and Wisdom, far from being one,
> Have oft times no connection. Knowledge dwells
> In heads replete with thoughts of other men;
> Wisdom in minds attentive to their own.
> Knowledge is proud, that he has learnt so much;
> Wisdom is humble that he knows no more."

Whilst it is always simple to offer destructive criticism it is not always so easy to suggest a cure, but in this case I would venture to say that it should not be difficult to raise the standard of education in the universities. The main difficulty which confronts most teachers is the large number of students, the majority of whom enter for their collegiate career not with a desire to acquire knowledge or wisdom, but to gain a degree which is a stepping stone to government employ. This factor is the real cause of the maintenance of a low standard. A simple remedy lies to hand, namely, the extension of Civil Service Examinations to all grades in the clerical departments of government. Such examinations are the general rule in other countries, and in India they are held for the higher grades, but for ordinary clerkships the primary requirement is a university degree or some other educational qualification. I would recommend that in the place of laying down an educational standard as a preliminary to employment that admission should be by competitive examination. I am willing to admit, that the introduction of this system would in all probability lead to the formation of cramming institutions, but whatever may be the defects of these, they would liberate the universities from their present thraldom and enable them to devote themselves to their true function, the advancement of learning.

The Importance of the Study of Natural Products.

Having completed my survey of the early history of our Congress I will for the remainder of the time which is at my disposal be somewhat more technical.

And Nature, the old Nurse, took
The child upon her knee
Saying, "Here is a story book
Thy father has written for thee."

"Come wander with me," she said,
"Into regions yet untrod,
And read what is still unread
In the manuscripts of God."

And whenever the way seemed long,
Or his heart began to fail,
She would sing a more wonderful song
Or tell a more wonderful tale.

In days not so far distant the man of science was not a specialist. Although by profession he might be a geologist or botanist, he could maintain a very thorough appreciation of all developments in the world of science. Thus Bacon in his catalogue of experiments to be done, which was appended to his "*Novum Organum*," was able to range from a subject such as "Fiery Humours" to that of the "Nature of Numbers." Our breadth of outlook must now perforce be much more limited, and even in the subject which we profess it is possible only to be master of a limited portion of that subject. Deplorable as this may be, it is, I am afraid, a factor which will-remain unaltered, and with the rapid development of scientific research is likely to be intensified unless the suggestion recently advocated by the Bishop of Ripon be adopted. I would plead this as an excuse, if in what follows, my language should at times be technical and difficult of understanding by those who are not chemists.

My own investigations have been concerned in the main with the study of the chemistry of natural products and as a result I have been brought into fairly close touch with such related subjects as botany, geology, and medicine. In the illuminating address of my distinguished predecessor to which many of us had the privilege of listening last year, he outlined some of the beautiful methods which he has devised for probing the secrets of plant life. In comparison, the methods of the chemist may appear to be somewhat crude, they attack the position from a different angle, but one from which results of equal importance are likely to result.

One of the objects of the chemist is to separate one by one the various individual substances present in living matter and

to determine their structure by analytic and synthetic methods. It is fascinating to consider the advance in our knowledge from 1806 when Sertürner first isolated morphine from opium, to the present year distinguished by Barger and Harington's brilliant synthesis of thyroxine, the active principle of the thyroid gland.

The interest of the study of plant and animal products is not confined to the laboratory, but extends into the economic world. As an example of this, I would commend to your attention the excellent work of Annett and his collaborators on the relationship of the alkaloidal content of the poppy juice to the age of the plant and to external features such as the nature and previous treatment of the soil. All true lovers of science must deplore the circumstances which led to the curtailment of this investigation, since it is only by detailed and painstaking studies of this type, that we can pass to the many more complex ones which await solution.

I have always considered it somewhat remarkable that so little attention has been devoted by organic chemists in India to the study of natural products, most of their researches being concerned with abstract problems. It must be admitted that problems of the former type are difficult and offer little attraction to those who estimate work by quantity and not by quality. In the Quarterly Journal of the Indian Chemical Society, which is now in its fourth year, I have only been able to find nine papers which deal with the chemistry of natural products. Is it presumptuous to suggest to the organic chemists of India that they should study intensively the unique wealth of material which lies at their door, and devote less time to the study of problems of theoretic interest only?

An important advantage of this branch of research work is that it brings one closely into contact with other sciences. In the study of plant products contact is first established with the botanist. Without his skilled aid it is not possible to be sure of the identity of your material, and it has been brought constantly to my notice how much excellent work is lost by the lack of botanical identification of the material used in the investigation, or by its inaccurate identification. Systematic botany is by no means simple, and it must be borne in mind that it is rarely possible to identify with certainty a piece of bark or a root. It is not alone the chemist who benefits by the collaboration; it is well known that in many cases with closely related species herbarium identification is almost impossible To quote what may be regarded as a classical example—no skilled observer in the field has any difficulty in differentiating the two grasses known as "*Sofia*" and "*Motia*" yet in the herbarium they are both classified as *Cymbopogon Martini*, Stapf. The distinction is of the greatest technical importance since the oil obtained from the "*Motia*" grass yields the well-

known and valuable palmarosa oil, whilst from "*Sofia*" grass only a comparatively valueless and quite different ginger grass oil results. The chemical differentiation of these two oils affords no difficulty. The position is similar in the case of many other grasses, the difference between the chemical constituents being far more marked than any morphological variation. During the course of my own investigations I have come across a number of cases of this kind, and I would like to suggest that it might be worth while to make a detailed botanical and chemical study of the various *Cymbopogon* grasses in which India is so rich, in order to determine whether a chemical classification would not prove to be more satisfactory than a purely botanical one, as I think that it will be generally admitted that, in spite of the laborious researches for which we are mainly indebted to Dr. Stapf at Kew, the present position is far from being satisfactory. A study of this nature might throw some light on the question as to whether the chemical constituents of the oil derived from the same grass vary with climatic conditions and with the nature of the soil. The analysis of essential oils is now sufficiently advanced for work ot this nature to be undertaken with every prospect of success.

I do not wish to claim any originality for the suggested substitution of a chemical for a botanical classification. In Australia, Baker and Smith in their remarkable work (1) on the differentiation of the various species of *Eucalyptus* have already found this to be the only satisfactory method. In this connection I would like to direct attention to the case of *Eucalyptus dives* which has been studied recently in some detail by Penfold and Morrison (2). This tree, which is the common broad leaf peppermint, occurs in Australia over enormous tracts of country, and the oil from the leaves has become of importance owing to the occurrence in it of from forty to fifty per cent. of the ketone piperitone, a commercial source of thymol and menthol. With the increased economic demand it was found that certain oils said to be obtained from the leaves of *E. dives* only yielded from five to twenty per cent. of the ketone. They were at first regarded as adulterated. It was, however, shown that they were genuine oils and that *E dives* existed in at least four varieties which were morphologically absolutely indistinguishable both in the field or in the herbarium, thus differing from the grasses "*Motia*" and "*Sofia*." At first sight, this difference might be expected to be due to soil or climatic conditions but this does not appear to be the case, since the different varieties breed true when grown in pots. This opens up a very difficult chemico-botanical field of research, which may not be without bearing on cognate agricultural problems, but I would submit, that it substantiates my claim for the value of a chemical rather than a botanical classification in difficult cases.

In the opening remarks to this section of my address I

referred to geology as one of the sciences with which investigators of natural products were brought into contact. One of the most interesting and difficult of border line subjects is the much debated problem of the origin of the petroleum oils. During the examination of the essential oil obtained from the oleo-resin of *Pinus excelsa*, which occurs in the United Provinces, it was surprising to find that the oil contained a considerable quantity of the paraffin hydrocarbon, undecane. This fact, together with the occurrence of pentane in the oils from *Pinus Sahiniana* and *Pinus Jefferyi*, both habitants of North America, not unnaturally led to the consideration of the question of the origin of petroleum, more especially since remains of the coniferae have been found in the earlier strata.

I do not propose to detain you with a detailed and historical account of the various theories which have been advanced to explain the occurrence of petroleum oils. I do not suppose that anyone now seriously doubts that they are of organic origin, a view which is supported by the fundamental fact, that the oils show optical activity. This side of the subject has been discussed by Rakusin in his book "Die Polarimetrie der Erdöle." If we accept, as I think we must, an organic origin for the oil, is it necessary to assume that all the oils have the same organic origin? I would suggest that such an assumption is not necessary, and I would further suggest that in different areas the mother substance may have been different. According to Engler's views (3) the oils are formed from animal and plant fats, their optical activity being due to the presence of cholesterol or its decomposition products in the higher boiling fractions. Amongst other evidence he adduces in support of his theory the fact that the optical activity is always found in the same fractions in oils from different sources. Recently Zelinsky (4) has attempted to provide evidence in support of this theory by laboratory experiments which, in my opinion, can hardly be regarded as convincing. He has shown that when cholesterol is treated with aluminium chloride oils are formed which closely resemble the natural petroleums, and he has further shown that the same fractions of these oils and of the natural oils show optical activity. Treatment with aluminium chloride is somewhat drastic and can hardly be considered as analogous to reactions taking place in nature. Until, therefore, the presence of cholesterol or one of its degradation products has been detected in petroleum oil Engler's theory, attractive as it may be, cannot be considered as established.

Another possible mother substance has been suggested by Ormandy, Craven, Heilbron and Channon (5) in the hydrocarbon, spinacene, which has been shown by Chaston Chapman, Tsujimoto and others to be widely distributed in fish livers. The investigations of Heilbron and his collaborators would

appear to leave little doubt that this hydrocarbon is a member of the terpene group, and readily undergoes polymerisation and degradation. Furthermore it is optically active. If marine animals be accepted as a source of the petroleums, I consider that this hydrocarbon may with equal probability be regarded as the cause of their optical activity and possibly with a greater degree of probability, since the quantity present would be likely to be greater than that of cholesterol.

In 1922 I was led to consider whether the mineral oils in certain cases might not have originated in resiniferous trees rather than in marine organisms. The resin-bearing trees contain potentially large amounts of material capable of yielding by simple chemical changes both alicyclic and cyclic hydrocarbons. Some support appeared to be afforded for this suggestion by the fact that in Burma large quantities of fossilised remains of *Dipterocarps* are found in strata adjacent to the oil-bearing strata. The various species of *Dipterocarpus* yield an oleoresin known as *Gurjun* balsam. In Burma the two principal species are *D. turbinatus*, Gaertner and *D. tuberculatus*, Roxb. yielding the so-called "*kanjin*" and "*in*" oils. Not being a geologist, I consulted my geological friends but received little support for the suggestion and I was therefore extremely cautious in my published paper, (6) expressing myself as follows: "In view of the fact that the members of the coniferae have been found in the early strata, it would appear to be possible that they were, at any rate in certain areas, one of the sources of the petroleum now found there." This suggestion [1] seemed to me to be of some importance, since, if it were correct, there was the possibility that the occurrence of forests of resiniferous trees might indicate the presence of petroleum-bearing strata, a subject worthy of investigation by geologists.

I have therefore read with more than ordinary interest a monograph entitled "The Geology of Oil, Oil-shale and Coal" by my friend Dr. Murray Stuart, a former member of the Geological Survey of India. It would lead me too far to discuss all the interesting suggestions made by him regarding the formation of coal and oils, it is with the latter that we are immediately concerned. Dr. Murray Stuart advances strong experimental evidence for the view that it is not necessary to assume that the oils were originally formed in the strata in which they are now found, but that they may have been carried there by water being held in suspension in mud. They were subsequently deposited with this mud as a sediment. He then proceeds to suggest, after discussing the geological history of Burma during Tertiary times, that the oil now found in the

[1] In a discussion at the Chemical Society on the chemistry of petroleum (Chem. & Ind., 1925, *3*, 168) I again referred to this suggestion.

Pegu strata originated in the fossil wood of the Irrawaddy system. This fossilised wood belongs almost entirely to the genus *Dipterocarpus*. During the process of silification, which he assumes may have actually taken place in the Arakan Yoma Island between the first and second phases of the Himalayan uplift, the oleo-resin would be "ejected" from the wood and carried away with the mud by water and deposited in the Pegu strata. In so far as I am capable of judging Dr. Murray Stuart's theories, they appear to be sound, and I am prepared as a chemist to accept them as a correct explanation of the occurrence of this oil field. Professor Dudley Stamp, who has worked in Burma, is prepared to support Murray Stuart's views although he does not agree with him that the Arakan Yoma Forests were the source of the *Dipterocarpus*. To quote from his most recent publication (7) "If the chemists are satisfied as to the possibility of this material as the mother substance of the oil there seems no geological reason against the suggestion. ...... But Murray Stuart's idea will hold, provided he is willing to admit derivation of his material from the north. There, in beds of the same age as the oil bearing beds further south, vast quantities of fossil wood are found."

Whether these theories on the origin of petroleum will prove to be correct cannot be foreseen, but I think that they indicate how interesting may be the chemical study of natural products, and how it may help in the solution of problems belonging in reality to other departments of science.

The time at my disposal is now at an end, and I will not detain you any longer. It has been a great honour and privilege, at what will probably be my last opportunity of attending a meeting of this Congress, that I should have occupied the Presidential Chair. From afar I shall watch with undiminished interest your future success.

Bibliography.

(1) Baker and Smith—A Research on the Eucalyptus, especially in regard to the Essential Oils.

(2) Penfold and Morrison—*Journ. Roy. Soc., N.S. Wales.* 1927, *61*, 54.

(3) Engler—Das Erdöl II, 132 (1909).

(4) Zelinsky—*Ber.*, 1927, *60*, 1793.

(5) Ormandy, Craven, Heilbron and Channon—*Journ. Inst. Petrol. Technologists*, 1927, *13*, 1.

(6) Simonsen and Rau—*Ind. Forest Rec.*, 1922, *9*, 118.

(7) Stamp—*Journ. Inst. Petrol. Technologists*, 1927, 13. 40.

APPENDIX No. I.

Proposed Indian Association for the Advancement of Science.

Dear Sir,

The rapid expansion, during recent years, of the teaching of science throughout India as well as the multiplication of laboratories in colleges and institutions designed for research purposes has disclosed a lack of scientific organisation which calls for the attention of all those engaged upon educational and research work in the country. The isolated worker in India is, for the most part, deprived of the help afforded by scientific reference libraries and his difficulties are enhanced by the fact that he is removed from the European environment whence he draws in large measure his inspiration.

We feel that the disabilities under which science suffers in India would be in part ameliorated and that an impetus would be given to research work by the establishment of some central organisation after the manner of the British Association for the Advancement of Science, whereby different workers throughout the country might be brought into touch with one another more closely. The attention of the society might be directed to every field of enquiry and to every aspect of scientific activity whether purely theoretical or applied to those numerous special problems offered by the Indian Empire and peculiar to its natural and economic conditions. The study of endemic diseases, of the conditions governing agriculture and forestry, of engineering problems in the tropics and subtropics, of the natural products of plants and of the mineral resources of the country, all these subjects call for extensive and systematic research in the laboratories with which India is now equipped. Behind this there is the larger educational problem, that of presenting to the minds of the people the aims of science, its purpose and ideals, its value as an instrument of social and economic improvement.

The objects of the proposed society are similar to those of the British Association and they cannot be better stated than in the words which form the preamble to the constitution of that body: "to give a stronger impulse and a more systematic direction to scientific enquiry; to promote the intercourse of societies and individuals interested in science in different parts of the country; to obtain a more general attention to the objects of pure and applied science, and the removal of any disadvantages of a public kind which may impede its progress."

It is to be noticed that co-operation with the activities of the society would not preclude the publication of results in European periodicals nor in departmental journals dealing with particular branches of research; its primary aim is to afford medium of communication between workers in different parts of

India. Accordingly, it is proposed to establish an association which shall hold an Annual Meeting (sectional or otherwise) in the more populous Indian towns where papers might be read and discussed, the proceedings to be published in the form of an Annual Report. We invite your opinion as to the expediency of founding a society of this kind and would be glad to know whether, in the event of its successful inauguration, you would be glad to support it on the general lines indicated above. The success of the scheme naturally depends upon the extent and representativeness of the support accorded to it. We hope to arrange an early meeting in Calcutta where the details might take practical shape.

In conclusion, attention may be drawn to a most important aspect of the scheme, namely, that concerning the co-operation of Indians. We realise that the future of science in India depends upon the adequacy of the practical training which students receive in College laboratories, and furthermore, that nothing is better calculated to increase its efficiency than the inculcation of research as the ultimate purpose of all scientific knowledge. It is unnecessary to point out how many and varied are the problems awaiting solution or how intimately the social and economic future of India is bound up with the successful application of scientific methods to all the activities, whether agrarian or industrial, of the community. We cordially invite the participation of Indian scientists, convinced in the belief that in such measure as it is accorded the objects of the society shall more nearly approach fulfilment and its usefulness and permanence be assured.

The undersigned, who in response to a public demand for action are undertaking the task of arranging an informal plebiscite on the question, would be glad of the favour of your opinion, and request that replies be sent to either of the addresses indicated below :—

P. S. MacMahon, M.Sc. (Manc.), B.Sc. (Oxon.),
Professor of Chemistry,
Canning College, Lucknow.

J. L. Simonsen, D.Sc. (Manc.),
Professor of Chemistry,
Presidency College, Madras.

APPENDIX No. II.

Letters to the Provisional Committee.

Dear Sir,

As the result of a proposal circularised some months ago by us advocating the establishment of a Scientific Associa-

tion for India, we are in a position to state that there appears to be a general feeling favourable to the formation of some kind of scientific machinery similar to that which experience has shown to be of value in other countries. The opinions elicited are practically unanimous with regard to the necessity of a closer acquaintance on the part of those engaged in teaching with the practical needs of the country, of a more complete co-operation between Europeans and Indians in the spread of scientific culture in India, and of educating the commercial classes to its value as an essential factor of industrial regeneration.

There is, however, as anticipated, some difference of opinion as to the precise form in which such an association would be capable of performing the most useful work. After carefully considering the various opinions expressed and acting on the advice of Sir Thomas Holland, we have pleasure in inviting you to act upon a Committee with a view to arranging a Science Congress in Calcutta next cold weather.

A congress at which papers dealing with different branches of science were read and discussed, and a public lecture of a popular nature held, would demonstrate the utility of a society of the kind we advocate, and furthermore, would afford opportunity of discussing a practical scheme for making it a permanent feature in the future scientific development of India. It will be the duty of the Committee to determine the scope and constitution of the proposed association and its relations to existing societies in India. The following is a complete list of gentlemen to whom an invitation has been extended to form a Committee:—

Dr. N. Annandale, Indian Museum, Calcutta.

Dr. Bose, C.I.E., C.S.I., The Presidency College, Calcutta.

Col. Burrard, C.S.I , F.R.S., Surveyor-General of India.

Sir S. H. Butler, K.C.S I., Member for Education.

A. Chatterton, Esq., B.Sc., C.I.E., Scientific Advisor to H.H. The Maharaja of Mysore.

B. Coventry, Esq., C.I.E., Director of the Research Institute, Pusa.

Major A. T. Gage, I.M.S., Director of the Botanical Survey.

H. H. Hayden, Esq., B.A., C.I.E., Director of the Geological Survey.

D. Hooper, Esq., Indian Museum, Calcutta.

A. Howard, Esq., Economic Botanist to Government.

S. W. Kemp, Esq., Indian Museum, Calcutta.

Surgeon-General Sir C. P. Lukis, K.C.S.I., Director-General, I.M.S.

Dr. Mann, Principal, Agricultural College, Poona.

Dr. P. C. Ray, C.I.E., The Presidency College, Calcutta.

Major L. Rogers, I.M.S., Calcutta.

Dr. M. Travers, F.R.S., Director, Indian Institute of Science, Bangalore.

Dr. G. T. Walker, C.S.I., F.R.S., Director-General of Observatories.

Should you be able to act on the Committee and to take part in the proposed Science Congress, we should be glad of an early reply so that the necessary arrangements might be made as soon as possible. We should also be obliged to know whether, in the event of your acceptance, you could make it convenient to be in Calcutta about the end of September with a view to convening a preliminary meeting of the Committee.

We are, Sir,

Your most obedient servants,

P. S. MacMahon,
Canning College, Lucknow.

J. L. Simonsen,
The Presidency College, Madras.

Science Congress, Calcutta, 1912.

Dear Sir,

A Committee meeting will be held in Calcutta on Saturday, 2nd November, 1912, in the rooms of the Asiatic Society at 11-30 a.m. to arrange the Science Congress contemplated later on in the cold weather.

The following business will be considered:—

(1) Election of Chairman.

(2) Date of Science Congress.
Wednesday to Saturday (December 18th–21st) has been suggested.

(3) Allocation of proceedings.
It has been proposed to devote three days to the reading and discussion of six papers, two in the morning of each day, leaving the afternoon free for visits to places of industrial and scientific interest. On the fourth day a popular lecture might be delivered.

(4) Arrangements for place of meeting and matters connected therewith.

(5) Financing of the Science Congress.
It has been proposed to charge a small admission fee, say, eight annas per diem or one rupee for the whole series.

(6) Public facilities in the way of cheap railway fares for visitors to the Science Congress.

If unable to be present, you would materially facilitate the proceedings by kindly letting us have your opinion on the above points in ample time before the committee meeting in particular, with regard to:

(1) whether you would prefer the Congress to be held in January 1913,

(2) any suggestion you may have concerning the most suitable subject for the public lecture,

and (3) whether you would prefer some other method of financing the Congress admitting free public admission to all meetings.

We are, Dear Sir,

Your most obedient servants,

P. S. MacMahon,
Canning College, Lucknow,

J. L. Simonsen,
The Presidency College, Madras.

APPENDIX No. III.

Minutes of the First Committee Meeting.

Science Congress, Calcutta, 1912-1913.

A committee meeting in connection with the above was held in the Asiatic Society's rooms on Saturday, November 2nd, at 11-30 A.M., there being present

Mr. Hayden (in the chair), Messrs. Tomkins, Hooper, Kemp, Christie, MacMahon and Simonsen.

Letters of apology for absence were received from Sir A. Mukerjee, Col. Burrard, Dr. Mann and Mr. Howard.

Mr. MacMahon explained that the proposal to hold a Science Congress arose as a sequel to proposals for the foundation in India of some general form of scientific organisation on the lines of the British Association. He stated that as the result of an informal plebescite the vast majority of those engaged in scientific work were in favour of some form of organisation on the lines proposed in the circular appended[1] although opinions necessarily differed as to the most suitable form in which it might be found most useful. The object of the Science Congress was to bring together as many of those

[1] Appendix No. I.

concerned as possible with the view to ascertaining the practicability.

The proposal was then thoroughly examined by the committee and various working schemes considered. It was ultimately resolved to ask the Asiatic Society to undertake the management of a Science Congress annually in Calcutta similar to that proposed in the circular appended.[1]

It was resolved that this be circulated among all members of the informal committee for signature and forwarded to the Secretary of the Asiatic Society for their consideration.

A vote of thanks was passed to Mr. Hayden for his kindness in presiding over the proceedings and the meeting then terminated.

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[1] Appendix No.II.

Section of Agriculture.

President:—Rao Sahib T. S. Venkatraman, B.A., I.A.S.

Presidential Address.

The Indian Sugar Bowl and Agricultural Research in connection therewith.

I. Introduction.

Gentlemen,

Allow me first to extend to you a very sincere welcome to the Agricultural Section of this Congress. This section of the Congress was first inaugurated at its third session at Lucknow in the year 1916 and ever since it has been steadily growing in every respect. This is but as it should be because of the great importance of this staple industry to our country.

There are certain special circumstances associated with the current Agricultural Section of this Congress. The "Royal Commission on Agriculture in India" is still in our midst and this day only about a thousand miles from this meeting. Secondly, this Congress has had the rather unique privilege—I take it for the first time in its history—of having His Excellency our Agricultural Viceroy as one of its patrons. A third happy circumstance which, however, has been in operation for some time past is the steadily increasing interest which our legislatures and the public are taking in the development of Agriculture and the various problems connected with it. The reforms have directly contributed to this happy result.

Under these circumstances I cannot help feeling that it would have been more appropriate if an abler person than myself had filled this chair. There is, however, one excuse for me and one consolation for you; on such occasions the Chair possesses a value of its own apart from the individual occupying it, a value derived from its previous occupants and the other traditions associated with it.

Going through the addresses of the previous presidents, I notice that the subjects chosen for the address are either on General Agriculture or on the subject in which the occupant of the chair might have specialised. I have taken as my subject "The Indian Sugar Bowl" and trust to its contents to render the subject attractive to this audience, if my method of handling it falls short of your expectations.

II. India—The Original Home of the Sugarcane

It is now widely accepted that India was probably the original home of the sugarcane and that the knowledge of the

cane and the manufacture of an edible product from it was known in this country from very ancient times. In the early days—before the beginning of the Christian era and for some little time after it—the Indian production of sugar represented that of the world and the only one in it.

It will take some time to detail here the various data on which the antiquity of sugarcane in India is based. I shall, therefore, content myself with mentioning the more important of them:—

(i) Mention of the cane and its products is found in the earliest literature of our country and no other. The elaborate descriptions of Greek and Roman dinners do not contain any reference to sugar; the elaborateness of the descriptions renders it unlikely that the omission was accidental.

(ii) The sugarcane was so well known during the time of the Sakyas that they adopted it as their emblem. There is a reference to the plant in the Institutes of Manu thus taking us back to over a thousand years before the Christian era.

(iii) Authenticated records are available to show that the cane migrated to other countries either from India or from countries which originally would have received it from India.

(iv) Some of the indigenous canes, cultivated over large tracts in this country to-day, are the nearest approaches to the probable wild progenitor of the cane. These are also some of the hardiest in the world.

III. Its Migration to Other Countries.

China must have known of the sugarcane and its products very early—as it is repeatedly mentioned as tribute to the Emperor of China from the Indian border provinces. It is recorded that in 1270 A D., many sugar factories were flourishing in South China and sugar was available there at cheap prices.

It is more than probable that Java—which to-day supplies the bulk of the Indian needs in white sugar—also obtained the sugarcane either direct from India or through China. The trend of recent discoveries would render the former alternative more likely The cane has been in cultivation in this island from as early as at least 424 A.D.

The wars and conquests of the Byzantines, the Moors and the Crusaders took the cane to Egypt, Spain, the Islands in the Mediterranean and the borders of that sea on the European as well as on the African coasts. In the beginning of the sixteenth century, Venice was a very important port dealing in sugar.

The discovery of the New World and the subsequent colonization of that vast continent by the Spanish, the Portuguese, the Dutch, the English and the French brought fresh areas under cane and greatly contributed to adding to the contents of the world's sugar bowl. This great extension of area brought this important article of food within the reach of the ordinary consumer. In the olden days, when the world area under the crop was limited, the article was so costly as to allow its use only as a luxury or in medicine. "Like an apothecary without sugar" is an ancient proverb still current in Spain.

The study of the spread and development of the sugar industry in various parts of the world is very fascinating, as it is very closely associated with political and other changes. "Blood and tears, piracy and bitter despair, as also ambition, invention and great adventure are inextricably woven with the history of sugar in the world." By an irony of fate this sweet product is intimately associated with some of the darker sides of human nature, with wars and slavery. The cultivation of the cane demands the employment of considerable and rather exacting labour; and sugar plantations in the earlier days were some of the places where slaves were freely used to the advantage of the industry. In fact the abolition of slavery over the greater part of the world between the years 1825 and 1850 disorganized the industry in many places; and it is sad to contemplate that cane cultivation was at one time an inducement for continuing this blot on humanity.

IV. The Birth of a Rival—The Sugar Beet.

Up to the beginning of the nineteenth century the sugarcane was practically the master in the field as the one plant from which sugar could be obtained. At this period a formidable rival appeared in the shape of the sugar beet. The beet sugar industry was born under the boom of French and German guns and, during its earliest days, was largely nursed by Frederick William of Prussia and the Emperor Napoleon. It was a time when the two then most powerful nations of the world sought to give battle to each other not only on land and sea, but by each trying to starve the other in the matter of supplies. The beet root was one of the weapons with which Napoleon sought to support himself against England.

The free and large imports of Sugar into Europe from the Colonies had developed in the mother countries a craving for this important and agreeable article of food. When England effectively prevented sugar reaching France the great Napoleon smarted under it and engaged a band of scientists to discover an alternative for the sugarcane. He caused various plants growing in France and other European countries to be exam-

ined for the possibility of obtaining sugar from them. The birth of the beet sugar industry in Europe was one of the direct results of this gigantic endeavour.

With his immense powers as Emperor the beet sugar industry received so much patronage and encouragement at his hands that it had to pass through severe crisis when all this patronage became suddenly unavailable with the downfall of Napoleon. The industry was very much like a spoilt child, petted and fondled amidst luxurious conditions, suddenly thrown into the ordinary conditions of life. The beet sugar industry soon recovered itself, however, with the application of science and industry and is now a serious rival to the sugarcane. On the whole, the sugar beet thrives in regions where the cane is not at its best. This has tended to greatly limit the otherwise very severe competition which would have come into being between these two great rival sources of sugar. As it is the competition is keen enough and it is difficult to foresee at present what other rivals await us in the future. Will the world one day suddenly wake up to find proved the possibility of the manufacture of synthetic sugar on a commercial basis ?

V. THE INDIAN SUGAR BOWL—ITS CONTENTS AND COMPOSITION.

After these general observations on the world sugar bowl through the ages, let us pass on to a consideration of the Indian sugar bowl as it is to day, its contents and composition, sources of supply and, what might be termed, the economics of it.

Sugarcane and its products are consumed in our land in quite a variety of ways. First and simplest is its consumption as a fruit. This method is pristine in its simplicity, involves no outlay on mills or machinery and has no foreign competition to contend with. For obvious reasons, it does not, however, lend itself to being adopted on an extensive scale. It is limited in scope and confined to only such individuals as are endowed with a good outfit of milling apparatus in the shape of strong and sound teeth.

Secondly, there is the rather crude product resulting from the boiling down of the juice in open pans and now largely carried on as a cottage industry. There is an endless variation in the quality and composition of this article; but, where the process of manufacture is clean, the result is a wholesome and appetizing article of food, said to be richer in vitamine *B* than refined sugar.

The third product is what is generally known as "shakkar." This again is of two kinds, viz. (1) a product very similar to *gur* but in the powder form, the clarification and removal of impurities being done a little better than in *gur* manufac-

ture and (2) a more or less crystalline article which is recovered from a product called 'rab' after considerable loss of sugar in the process.

The market for this commodity rests chiefly on sentiment and religious scruples which, however, are gradually wearing out. Its existence is increasingly threatened by the competing factory-made sugar. To my mind, its future is limited to conditions, where it has the advantage of being run as a cottage industry.

Fourthly, there is the refined product as obtained through modern machinery in factories, of which there are a certain number in the country. So far these have largely been the result of foreign enterprise and are concentrated chiefly in Bihar. The number of such factories is altogether inadequate, as their total output in refined sugar is less than a seventh of our present consumption.

VI. Analysis of our Consumption and its Lessons.

It is both interesting and profitable to examine in detail our consumption of *gur* and sugar products during the year. Such an examination, besides enabling us to form correct ideas about the relative importance of each of the products to the country, should indicate the directions in which improvements are both important and urgent.

To facilitate comparison I shall take the figures in rough and round numbers. The annual consumption of *gur* and sugar combined is roughly a little over three and a quarter million tons. Of this about 75 per cent. consists of *gur* and *desi sugar.* Of the remaining 25 per cent. about 3 to 4 per cent. is crystal sugar *home made* in more or less modern factories and refineries working in this country. The remainder, i.e. between 21 to 22 per cent. has to be imported each year from outside, chiefly Java, at a total cost of about 15 crores of rupees. The lessons from the above analysis are obvious.

The bulk of the Indian consumption is in the form of *gur* and so all work directed towards increasing the quantity or improving the quality of *gur* made in the county either directly or indirectly are bound to be of immediate benefit to the Indian grower and consumer.

The *gur*, *gul*, *gud or jaggery* is a product rather characteristic of our land and enjoys a privileged market in the country partly from sentiment and partly because of the peculiar flavour associated with it. In the Indian bazaar this article is at times dearer than even the refined product, in terms of the crystal sugar contained in it. While the dumping of cheap white sugar into the country does often-times place it in a precarious position, it is likely to hold its own as a cottage industry for some considerable time to come. It enjoys a con-

siderable amount of protection from the Indian sentiment in favour of it and heavy transport charges from the coast to the places of consumption. The two principal drawbacks in this product are (1) the difficulty of keeping it for long periods and (2) the wide variations in quality and composition.

The figures for the refined article show that its production inside the country is very small—less than one seventh of the consumption—and an early increase in the supply of the home product would be necessary to make India self-contained in this important article of food and prevent the great drain to the country resulting from our heavy imports in this article. The urgency of the improvement will be better realised when it is remembered that with the advance of time the refined article shows an increasing tendency to replace the home made, but comparatively crude product, *gur* in the Indian kitchen.

VII. Present Location of the Indian Sugar Bowl—Outside the Country and across wide Seas.

From the foregoing it is clear that at present the Indian sugar bowl is not happily placed. In the matter of refined sugar our bowl is placed away from the country and across the wide seas ; and every time we have to stretch our hands to reach to it. With the experience of the recent great war the seriousness of the present condition will be readily realised and there could be little doubt that it needs serious and urgent attention.

There is yet one other, rather startling, fact which renders our position particularly pitiable. Not only is it that the cane probably originated in India but even to this day we have in the country nearly half the world area under the crop—an area easily greater than that of any other single country in the world. That, inspite of this vast area, India has to import annually large quantities of white sugar from outside results from two causes. One is that the acre yield in this country is comparatively low, being less than one third that of Cuba, one sixth that of Java and one seventh that of Hawaii in terms of sugar. The second is that the factories in the country are too few and, have often to struggle with a poor class of cane equally disadvantageous to the grower and the manufacturer.

VIII. The Problem and its Remedies.

Glancing through the work that has been done on this crop in the past—and such work began largely with the founding of Agricultural Departments all over the country—one finds that until recently it was mainly directed to the solution of local problems. In one case it was perhaps the introduction of a new cane to secure increased yields or to fight out an existing disease,

and, in another, improvement in methods of *gur* manufacture, either to prevent losses or to make the process more economical. Very valuable work has been done in these directions; but the fact remains that till recently no attempt was made to attack the Indian sugar problem as a whole and in all its bearings.

It was in the year 1911 and during the pre-reform days that, an unofficial Indian member of the Imperial Legislative Council of those days, the Honourable Pandit Madan Mohan Malaviya, drew prominent attention to the unhappy condition of the indian sugar industry, a position which was steadily growing worse with the advance of time. The All-India Board of Agriculture paid marked attention to it in the year 1911 and subsequent years and made definite recommendations. This period really marks a new era in the history of the industry, as with it begins the tackling of the problem as a whole and on all-India basis. The Indian Sugar Committee which followed in the year 1920 and the very careful and detailed recommendation made by that painstaking body greatly contributed to the clear elucidation of the difficult problems associated with the industry.

I have already mentioned that the indian yields are very poor as compared with those of other countries. This is mainly due to two causes. One is the poor quality of cane grown over the bulk of the indian area and the other is the considerable loss from the wasteful methods of manufacture adopted at present.

Improvements in methods of manufacture of *gur* and country sugar are very important, confer an immediate benefit on the people connected with the industry and have been receiving attention in all the provinces. But the problems associated with it are often rather local in character. Not only the conditions but the requirements of the *gur* market vary widely from place to place.

In the matter of improving the type of cane grown, the first and obvious line of attack adopted in earlier years is that of importing improved types from a different locality or from a country overseas. It soon turned out, however, that such types were not useful over the bulk of the indian cane area which is situated in sub-tropical regions.

The indian canes, though comparatively poorer, possess certain very useful characters. They are very hardy and having been grown in the country for very long periods are eminently adapted to what are generally considered unfavourable conditions for cane.

The remedy was obvious. It consisted in trying to combine in a new cane or canes the superior qualities of the tropical types with the hardiness and growth characters of the indigenous kinds. The results have been eminently satisfactory as will be shown in the course of the address, and involved the breeding of new seedlings after rather complicated hybridization.

As the work is rather new and possesses certain characteristic features it would not be out of place here to briefly review the salient features of this work.

IX. Sugarcane Breeding.

The breeding of sugarcane differs in certain essential respects from that of most other crops. For one thing the growing of plants from seed does not, with most others, offer any special difficulty. It is not so, however, with the cane. Certain varieties do not flower at all, others are infertile in one or both of the essential organs and the young seedlings are generally rather delicate in the early stages and need considerable care to nurse them to maturity. Secondly, in the cane the plants from seed do not resemble one another or either of the parents, even when precautions are taken against chance hybridization in the field. Thirdly, the inheritance of characters in the cane has not yet been traced to any well defined laws, which places the breeding of canes in a class by itself. The cane-breeder is wholly unable to know beforehand what kind of seedlings to expect from a particular combination and, in the present state of knowledge, has largely to depend upon increasing the chances of obtaining the desired combination by growing a very large population. The number of seedlings raised each year at Coimbatore has often exceeded a hundred thousand and it is often a job, in the first instance, to grow and later to select from such a large number.

But conditions are, however, steadily improving. The technique of breeding which involves some research has been considerably simplified and rendered more reliable in recent years, the station at Coimbatore contributing to some extent in this good work. Secondly, though definite laws have not yet been established in connection with the inheritance of characters in the cane, data are rapidly accumulating as to the type of seedlings each variety may be expected to yield. All these are steadily introducing greater certainty in cane breeding operations, though it may yet be long before mathematical accuracy, like that now associated with the breeding of most other crops, is available for sugarcane.

Every cloud, it is said, has a silver lining and the work of the cane breeder is not without certain compensating advantages. When once the improved cane is secured its further multiplication is a comparatively easy matter. The method of vegetative multiplication through cuttings—which is the method adopted in ordinary cultivation—ensures the reproduction of the superior qualities more or less intact in subsequent crops.

The breeding of canes at Coimbatore was started only in the year 1912 and this day as many as over 20,000 acres are

under the improved Coimbatore canes. The Coimbatore canes give yields which are sometimes 100 to 160 per cent. superior to those of the indigenous varieties; and a conservative estimate of the additional profit to growers has placed it over 14 lakhs of rupees during the season just passed.

By itself, it has to be admitted, this is not a big saving for a big country like India; but even so it needs to be mentioned that it is over 28 times the annual expenditure on the station. When it is realised that the total cane area in India is about 2¾ million acres, that these improved canes have only just started getting into cultivation, and that the 20,000 acres now grown with the improved canes represent less than one per cent. of the possible area, it would readily be conceded that the future possibilities are indeed great. Cane breeding has conferred great benefits on more than one country in the sugar world and experience so far gained in India would indicate that, if anything, the benefits would be greater to this country. The data already to hand fully justify my stating that cane breeding is going to be one of the most effective means for making India self-contained in the matter of sugar, if not for exporting it.

X. The Factory Industry.

But the breeding of canes at Coimbatore is only the beginning of the problem. It is perhaps also the only right way of beginning it, because, without the right cane to grow in the field, it is both futile and risky to develop in other directions. It has also proved a very hopeful and auspicious beginning. In a very short period it has knocked the bottom out of the belief widely held that profitable cane crops could not be grown over the bulk of the indian cane area because of its sub-tropical conditions. Over parts of Bihar it has shown that yields could be doubled over large areas with but little alterations in cultivation methods.

The fact appears to have been, not that the bulk of the indian area could not grow profitable cane crops, but that so far science had not been diligently applied to the problem. The indian canes have in them certain very useful characters—discovered and utilised by Java as early as the nineties of the last century—and a rather complicated hybridization with the tropical canes, roping into the parentage certain wild grasses allied to the sugarcane, was needed to yield the improved types which would grow and flourish in the indian cane area. The range of varieties available in our country is very large—much larger than in most others—and a continuous application of science is all that is needed to steadily augment our present low acre yields. Java, within the last sixty years, has shown the utility of the application of science to the industry. Her

acre yields which in 1860 were only about 1½ tons are to-day well over 5 tons.

Now that the improved canes are available and would be so in increasing numbers in the future to suit the varying conditions of Continental India, it now remains to organize and improve in various directions the subsequent stages in the industry. The ideal before a breeder ought to be to evolve types suitable to any given set of conditions, and cane breeding should therefore be equally useful to the growers, whatever may be the manufactured product in individual cases. The Coimbatore-bred canes have already proved this. They have benefitted equally the small grower preparing *gur* as a cottage industry, the planter supplying canes to the modern factory and the factory itself.

These improved canes with their higher yields and other advantages are bound to bring up for solution other problems such as the need for a better system of manuring and cultivation, adjustments in factory operations and disease incidence, in the last of which, breeding should again prove useful. Nature is loath to bestow a gift without some hard fighting.

The one immediate problem before the country is to make India self-contained in the matter of sugar; and so far as one is able to see at present, the founding of more factories in the country is the only solution. I have the authority of experts in the field, experts with plenty of experience of all the aspects of the sugar industry in other countries, to state that there is scope in the country for the founding of such factories. The problem is not without difficulties; but it has truly been said that difficulties exist only to be overcome.

The Imperial Department of Agriculture in India has taken in hand other phases of the problem besides cane-breeding. One such is the Sugar Bureau at Pusa which has already proved its usefulness to all connected with the industry.

XI. Sugar as Food.

Before concluding this address there are one or two points to which I wish to draw particular attention. One is the increasing recognition of sugar as an agreeable and valuable food. As to its agreeableness no proof is needed. It is within the personal experience of all of us here. Its food value, however, is not so well known.

Food for human consumption may be broadly divided into two classes, viz. maintenance foods and fuel or energy foods. Sugar belongs to the latter class and is very valuable as such. In the recent Great War, it is said, look-outs on ships used to be specially rationed with sugar on stormy nights. Arctic explorers and mountain climbers like Sir Earnest Shackleton and Dr. Malory have testified to the value of sugar as an energiser. Sugar

is the cheapest food for purchasing energy. An anna would buy 545 calories when laid out on sugar as against 395 for bread, and 180 for milk. It has been claimed that a very minute variation in the glucose of the blood may make the difference between cowardice and courage, may determine if a man is to be shot as a slacker or medalled as a hero.

XII. Sugar and Diabetes.

There is a wide-spread belief that sugar is responsible for diabetes. In certain quarters it has been blamed for cancer and rheumatism as well. A recent careful examination of the data has shown, however, that there is no justification for these beliefs. On the other hand Dr. Ralph Pemberton of Philadelphia has recently credited it with conferring some resistance against certain diseases. It is further significant that in certain varieties of corn and wheat a positive correlation has recently been established between the sugar contents of the sap and resistance against certain fungus diseases. I have already stated that in the earlier days—when the world supply of this article was scarce—sugar found considerable use in medicine. It might again prove useful in this direction. Antiseptic properties have been claimed for it and it is one of our best preservatives for fruit as illustrated by the jam trade.

XIII. Conclusion.

It is certainly pleasing to our vanity to be told that our country was probably the original home of the sugarcane. But the fact by itself is neither a consolation nor a help in our present unhappy dependence on outside countries for this admittedly valuable article of food even to meet our own needs. It is no consolation for a bankrupt during his darker hours to remember that once he too had plenty of the good things of the world. The remembrance would only increase the misery of the subsequent unhappy situation.

Deplorable as our present condition is, the future outlook is, if anything, the gloomier. At present our consumption of sugar per capita is between a fourth and a fifth of what it is in the most advanced countries of the world. As our consumption increases with the advance of time—it is bound to and has steadily done so in the past—our dependence would only increase if effective steps are not taken in the meanwhile. Not only that, sugarcane is a valuable and important crop in the main cane-growing provinces and the loss of the crop through the dumping into the country of cheap foreign sugar would seriously upset agricultural conditions in the country.

In ancient days the indian sugar bowl was probably the one and only one in the world. To-day, and through our not keeping

abreast of the rapid development in other lands, it has become a veritable begging bowl; and India has to stand at the doors of other countries for her needs in sugar. Our area is large, the white sugar belt of North India alone containing an area almost equal to that of Java. The auguries may also be deemed favourable as the first activities of the Central Government have already yielded very encouraging results. It only remains to put more energy into the work so well begun.

Section of Agriculture.

Abstracts.

1. Electricity and Agriculture.

T. J. MIRCHANDANI.

This paper deals with the employment of electricity in agricultural and allied industrial operations.

Part I.—Power demand for domestic purposes, dairying, poultry farming, ploughing, electroculture, rice cultivation, etc., is reviewed and estimated and the suitability and limitations of utilizing electricity discussed.

The effect of electric working in tea and sugar production is examined : the possibility of starting, on a small scale, industries like oil milling, fruit preserving and drying and hide curing is suggested.

Use of electricity in land drainage and irrigation schemes and in fertilizer manufacture is emphasized.

Part II.—Cheap power being the prime condition of electrification, a distribution scheme affording reasonable safety and flexibility with minimum cost is outlined: constructional details and costs of tapping high tension mains are given : difficulties encountered by urban companies in supplying the countryside are indicated: the suitability of hydro-electric networks for agricultural supply is emphasized.

Alternatively, the possibility and cost of local generation by oil, wind or waterpower are examined: the automatic features necessary in the switch-gear are enumerated.

Essential features of wiring and motors and equipment construction are given.

In conclusion, it is shown how India, like France, may shortcircuit the oil stage in farm mechanization by developing her waterpower.

2. Root development in rice under different conditions of growth.

R. L. SETHI, Cawnpore.

Four different types of varieties of rice, possessing early, medium and late characters, and also with fine and coarse nature of their spikelets were grown in pots in different soils and treated with different manures. They were washed out at different periods, and the dry weights of root and shoot were noted. Their shoot and root ratio was also worked out, and represented graphically. Observations were also made in the field of early (broadcast) and late (transplanted) kinds sown under different conditions. Also anatomical differences in different types of roots is shown. The paper also contains photographs of roots under different habitats.

3. A study of the locular composition in Cambodia cotton.

V. RAMANATHA AYYAR.

It is aimed in this paper to work out details pertaining to the inter-relationship of locular composition of bolls with the various other economic units which contribute to yield in the cotton plant. It is found that the carpellary composition is disturbed as the season advances and that five-locked bolls, generally produced early in the season, are more susceptible to shedding than four-locked ones. A positive correlation is

observed to exist between the number of five-locked bolls and the remaining bolls produced by a plant thus showing that a plant with a large number of five-locked bolls will tend to be a heavier yielder. A correlation in the negative direction is noted between the locular composition and its ovular contents and no such relation is seen as regards the number of seeds set per lock provided the number of ovules is kept constant. It is further observed that while the maturation period remains to be the same, the weight of kapas per seed is affected by locular composition and the latter conclusion is of economic significance to the plant-breeder in making out samples to determine the lint weight per seed.

4. Factors influencing the growth and sugar contents of cane.

K. KRISHNAMURTHI RAO.

A comparative study of the temperature and water conditions, favourable and unfavourable for cane growth, has been made from published and unpublished records and notes. It is indicated as a result that, an average mean temperature of 78° F. and a well distributed rainfall conduce to a good growth, whereas a mean temperature below 65° F. and a sporadic and uncertain rainfall affect the cane growth prejudicially.

Based on these general considerations, the climate and rainfall of several important cane-growing countries like Java, Cuba, Hawaii, etc., have been examined in relation to their output of sugar, and compared with the various cane-growing provinces of India. It is found that the greatest output of sugar and the maximum yield per acre are obtained in countries situated within the tropics, whereas sub-tropical regions record a less satisfactory output and yield. Containing as she does at present, the bulk of her sugarcane growing area in the sub-tropical regions, to attain a high level of sugar production India must necessarily grow in the main medium sized and hardy canes.

Other secondary factors governing the growth and sugar content of cane such as (*a*) rainfall on ripe canes, (*b*) continuous moist weather and absence of well defined ripening seasons, (*c*) soil, (*d*) quality of irrigation water, (*e*) manure, etc., are considered in brief.

5. Studies in the chemistry of sugarcane. The applicability of the top-bottom ratio method for testing the maturity of sugarcane crop.

B. VISWA NATH *and* S. KASINATHA AYYAR.

The applicability of the top-bottom ratio method to field conditions, and the advantages of this new method in manurial and varietal experiments are discussed.

6. Tests with Indian *Andropogon sorghum*, Var. *techn.*, under European conditions.

S. S. NEHRU.

In the *last paper* read at Lahore, it was explained how a certain quantity of specially selectivised, hardened, resistant Broomcorn seed had been obtained in India. Some of this experimental seed was distributed by *request* to various public and private bodies in Europe, which were interested in sorghums generally and in this variety in particular, but which had failed to get the plant to grow for reasons of latitude or altitude or both. The obvious reason why the local european varieties failed was that they were not resistant enough.

The indian seed is much more resistant than the european variety. Positive results obtained from the under-mentioned experimental areas will be communicated : —

I. In *England* : 1. Rothamsted Experimental Farm.
2. St. Albans.
3. Vowchurch, Hereford.

II. In *France* : 1. Cornimont, Vosges Hills (400 m.).
2. Dompierre, Vosges Hills (550 m.).

III. In *Germany* : 1. Botanical Gardens of the University, Heidelberg.
2. Haardt Hills.

IV. In *Switzerland* : 1. Arosa, Grisons (1800 m.).
2. Arosa, Grisons under different conditions.

V. In *Italy* : 1. Tuscany.

VI. In *Algeria* : 1. Agricultural institute of the Governor-General in Algiers, Seed Station, Maison Garree.

The superiority of the indian seed may be taken as fully established. It has grown at all heights and under all conditions, even where local sorghums have proved failures.

An explanation of the underlying process of hardening, which has been described in previous papers read at the Indian Science Congress and which is undoubtedly the cause of the above superiority will be attempted.

7. The occurrence and inheritance of spikelet tipped bristles in *Setaria italica.*

G. N. RANGASWAMI AYYANGAR, Coimbatore.

The bristles in *Setaria italica* are barren branches of the inflorescence subtending shortly stalked spikelets. A race has been met with in which bristles bear fertile spikelets. This character behaves as a simple mendelian recessive to the usual barren bristles. This behaviour in inheritance of this evolutionally significant character is interesting.

8. Protozoa as a factor controlling the fixation of nitrogen in soils by azotobacter.

H. S. MADHAVA RAO *and* ROLAND V. NORRIS, Bangalore.

The paper describes experiments with partially sterilised soils, the temperatures to which the soils had been subjected varying from 60°C.—100°C. Four series were run :—(1) soil alone, (2) soil inoculated with protozoa, (3) soil inoculated with azotobacter and (4) soil inoculated with both protozoa and azotobacter. The crop grown was *ragi* (*Eleusine Coracana*). Weekly samples were taken and protozoal and bacterial counts made, nitrogen being also determined. The relationship between the bacterial and protozoal numbers is discussed and the influence of the various experimental conditions employed on nitrogen fixation and crop growth described.

9. Some investigations on the effect of high concentration of organic or ammoniacal nitrogen on nitrification in soil.

N. V. JOSHI, Pusa.

In testing the nitrifying power of soils and in the biological examination of soils, varying amounts of organic or ammoniacal nitrogen are

added; and the soils are known to vary in their capacity to nitrify the amounts of nitrogen thus added to the soil. In case of higher amounts of nitrogen added to the soil, nitrates do not accumulate in the soil. This is generally explained by the assumption that nitrifying bacteria do not thrive in the presence of large amounts of organic matter or ammoniacal nitrogen. Some experiments carried out by the author did not, however, tend to support this assumption, inasmuch as nitrifying bacteria were found to be working normally in the presence of large amounts of organic matter and ammoniacal nitrogen, after a process of what may be called activation; and hence it was suggested that the previous failures to accumulate nitrate observed by many investigators were probably due to the absence of sufficient number of nitrifying bacteria and not due to the physiological inactivity caused by the non-tolerance of the higher concentration of organic matter or ammoniacal nitrogen by the nitrifying organisms. By the direct addition of an inoculum of nitrifying organisms to an ordinary cultivated soil, which could not otherwise show accumulation of nitrates in presence of large amounts of organic matter or ammonium sulphate, it is now definitely shown that nitrates could be made to accumulate in the soil within the usual limits of time allowed for nitrification in soil, viz. 4 to 8 weeks. An attempt is also made to further corroborate this by the microscopic counts of bacteria and a certain amount of correlation was found to exist between the numbers of bacteria observed in the differently treated soils and the nitrates accumulated therein.

10. A method of increasing the manurial value of mahua cake.

N. D. Vyas, Pusa.

Mahua cake by itself is not a very active manure and its application to the fields without any treatment is not very profitable.

If, however, it is mixed with soil, or with charcoal, or with soil and charcoal it ferments quickly and the greater portion of its nitrogen is rendered nitrifiable.

A suitable compost is made up of a mixture of 100 parts of finely powdered mahua cake, 25 parts of soil, 5 parts of charcoal, 65 to 70 parts of water. The mass is allowed to ferment for a period of three months. When once the compost is prepared, an occasional sprinkling of water over the heap is all the attention needed.

Plots treated with the compost of the above composition gave an increased yield of Oats by 30·8 per cent. over control and 20·4 per cent. over the plots manured with fresh cake.

11. The physiology of the sulphur-oxidising organisms from activated sludge.—Part II.

C. V. Ramaswami Ayyar.

The influence of involution forms, the effect of aeration on the culture and of diffused light and of total darkness on the rate of sulphur oxidisation by the organisms are described. Observations on the nature of the carbohydrate metabolism are recorded. The sulphur-carbon ratio in the presence of normal and involution forms has been investigated. The results obtained suggest that the organism is of a distinct type from the sulphur-oxidising organism studied by Joffe and his co-workers. Experiments on the influence of surface, especially of charcoal from various sources, on the growth and activity of the organisms have been carried out and the results are discussed.

12. Mechanical analysis of manures by the elutriation method with special reference to mineral phosphate.

C. V. RAMASWAMI AYYAR.

Stadler's modification of the Schoene Elutriator employed for the mechanical analysis of glass-sands, etc., with slight alterations to suit local conditions, has been utilised and its standardisation for the grading of soil particles is described. Its special application to the grading of mineral phosphate has been thoroughly investigated and mechanical composition of the latter ascertained. The distribution of the more important chemical constituents in the different fractions was also studied. Data are available to assign a tetra-calic constitution for the phosphate present in the sample.

13. Preliminary investigation on the nitrogen-fixation in the Hyderabad soil.

K. HABIB HASAN *and* N. N. INUGANTI, Hyderabad, Deccan.

Two kinds of soils, garden and field, were selected to find out the limit of nitrogen fixation by azotobacter. These experiments were conducted with soil taken from 6″ below the surface, inoculated in Ashby's mannite and Omelianky's solutions and incubated at 37°c for a period of 7, 14, 21 and 28 days when total nitrogen and nitric nitrogen were estimated respectively. The results will be shown.

14. Utilization of mahua waste as manure.

K. HABIB HASAN *and* MOHD. MAHDI HASAN, Hyderabad, Deccan.

This is a continuation of the work presented before the Science Congress at Bombay (1926). Experiments were continued to find out the optimum moisture conditions for nitrification of mahua waste and it was found that 15–20% of moisture was the optimum for the type of the soil used in these experiments (loam).

Fresh mahua waste was allowed to nitrify for 10 weeks at optimum moisture and the conditions were found to be such as to favour the least concentration of ammonia and nitrites. Side by side fresh cow-dung was similarly nitrified for comparison and the figures compare well in the early stages of the experiment.

Pot culture experiments with barley and wheat were conducted both with the mahua waste and cow-dung. The increase in the yield of the crops (grain and straw) obtained by mahua waste, though not as high as that obtained by cow-dung, is still far in excess of the controls.

The increase in yield obtained by the mahua waste could be attributed to the improvement brought about in the physical properties of the soil.

15. Sinews as a manure for rice.

MOSES EZEKIEL.

(1 maund=28 lbs.)

Two maunds of sinews for every maund of seed sown in seed-beds and two maunds more on the transplanted area gave excellent results under Thana conditions of soil and rainfall. The results lead us to the following tentative conclusions:—

1. Sinews can take the place of Rab in rice seed-beds.
2. They can be used as a general manure for rice in plots where the rice is transplanted.

3. They decompose quickly and give a vigorous start to the seedlings.
4. Thorough weeding by means of ploughs and other instruments or 'ploughing in' of the weeds is absolutely essential for the success of this method of preparing seed-beds.
5. They are cheaper than Rab burning or (Kutta) fish manure.
6. They exert a very favourable influence on the subsequent crop.
7. Almost unlimited quantities of sinews are available all along the G.I.P. line, and so may be used more extensively for manuring the land generally.
8. There is a local prejudice against the handling of them but where the untouchables do the handling and spreading cheaply they may bo safely recommended as a universal manure for supplying organic nitrogen to the soil.
9. Sinews do not require to be powdered or made finer than what they are, as sold by the bone mills and the operation of incorporating them with the soil is cheap and easy, and can be done by women and boys.

16. The estimation of the volatile fatty acids formed in the soils.

V. Subrahmanyan.

The acids, partly free and partly in the form of their salts, are extracted with water. The extracts are neutralized with alkali, concentrated to small bulk, then rendered slightly acid and steam-distilled at constant volume. A formula has been worked out for calculating the quantities of the individual acids present.

17. Bio-chemistry of waterlogged soils.

V. Subrahmanyan.

Waterlogging of soils leads to the formation of ammonia by the activity of a deaminizing enzyme present in the soil micro-organisms. The presence of decomposable organic matter causes a marked production of lactic, acetic and butyric acids.

18. The estimation of reducing sugars occurring in the soil.

V. Subrahmanyan.

Shaking with alumina cream and filtering brings out nearly all the sugars into solution. Direct titration against Fehling's solution if the quantity of sugar is large and back titration at constant volume if present in minute quantities have been recommended. Correction formulæ have been worked out for the traces of the sugars detained in the soil and for the reduction by the other forms of organic matter.

19. Mahua waste as food for Milch-cattle.

K. Habib Hasan *and* S. R. Bhate, Hyderabad, Deccan.

Mahua flowers after fermentation and distillation are fed to Milch cattle by local milk-men. The determination of their food value, their effect on the health of animals and the quality of milk were the subject of some feeding experiments undertaken for this purpose. The results obtained show that :—

(1) The food value of mahua waste is about 1/8 of Chunni or Bhusa.
(2) It is well digested and the animals relish it once they take to it.

(3) The health of animals does not suffer, if it is supplemented by nitrogenous concentrate.
(4) The percentage of fat goes down a little when compared to other concentrates.
(5) No undesirable smell of flowers is noticeable in the milk when they are fresh.

20. A new milk-fermenting Yeast.

C. S. Ram Ayyar.

The paper describes an yeast isolated from a sample of spoilt milk from Karnal, which has the property of fermenting milk into alcohol. The amount of alcohol produced from 1000 cc. of milk is 20 grams or nearly 80 per cent. of the theoretical yield from lactose. Gas production is vigorous in milk as also in most of the ordinary sugar media. Maltose is not at all acted upon.

The yeast ferments milk-whey easily after the removal of casein. Hence it is of economic importance in the production of alcohol from whey, which is at present thrown away in sweetmeat shops after the removal of *Chhana* or casein.

The optimum temperature for its growth is 30° C.

It does not belong to the class of true Saccharomyces as no ascospore formation could be observed.

21. An experimental hand-gin for American cottons.

R. K. Kulkarni.

1. The Surat-hand-roller-gin by which the indian types of cotton are ginned satisfactorily is not suitable for american cottons.
2. The Platt Brother's "Missionery" hand-roller-gin gins the american cottons satisfactorily and gives quite correct results and does not much differ from the factory gin.
3. The "Missionery" gin is well suited for ginning small quantities of seed-cotton such as is produced by single plants, and as such is very useful in breeding experiments with the cotton crop.
4. Tests conducted show that the "Missionery" gin is also well adapted for ginning indian cottons quite satisfactorily.
5. By the use of the "Missionery" gin a good deal of time and labour is saved in comparison with the Surat gin; but its initial cost is prohibitive.

22. A grape vine disease new to India.

Sohrab R. Gandhi, Poona.

In a vineyard near Nasik during 1926-27, many of the plants showed sudden drooping of the young shoots and leaves, with no other visible symptoms of disease. The presence of the fungus on the roots was betrayed by the existence of whitish loose bark at the base of the trunk. The fungus was identified at Pusa by the Imperial Mycologist, as *Dematophora necatrix* Hartig, a very widespread agent in destroying vines, fruit trees, potatoes, beans, sugarbeet, oak, pines and spruces in Europe. It has not been hitherto recorded in India.

Immediately after the discovery of the disease, the diseased roots for three feet round the base of the trunk were exposed to the sun, and the drooping young growths were cut down to the riper and healthier portions of the canes. The whole fungus was removed from the roots by scrubbing them with coir, and they were then washed with Bordeaux mixture and allowed to dry. After this a thin coat of tar was applied to the diseased roots, and they were covered. To this treatment the diseas-

ed vines responded wonderfully. They soon put out healthy growth and yielded a normal crop.

The Imperial Mycologist had suggested the exposing of the base of the trunk as far down as possible and the powdering of the trunk and surrounding soil with sulphur. This treatment also proved beneficial to some extent, but later observations indicated that both these treatments gave only temporary relief. Many, though not all, of the treated plants drooped in the fruiting season of the year 1927.

From the observations up to date, it seems possible to check the disease by proper soil sanitation.

23. Possibilities of Dry Farming in the Bombay Deccan.

N. F. KANITKER, Poona.

In extensive tracts of the Bombay Deccan the annual rainfall is most precarious and gives rise to frequent famines and scarcities. The possibilities of extension of irrigation are limited and hence the only alternative left to mitigate the effects of these precarious rains is to find out the possibilities of practising the system of Dry Farming followed under similar conditions in U.S.A., Australia, and South Africa. Experiments to find this out have been conducted since 1924 at Manjri near Poona by Soil Physicist to the Government. Preliminary laboratory work was directed to study the various physical properties of the soil on which the experiments are conducted. The two chief grain crops of the Presidency, one grown in Kharip season and the other in the Rabi season, were chosen for experimentation. From the results obtained for three years it can be said that the dry-farm methods if adopted in such precarious tracts, can secure a fair crop even in a year of considerable drought, while in a year of moderate or good rain they can give very much increased yields. The results so far obtained are very promising and indicate great possibilities of mitigating, partly at any rate, the famine in the extensive tracts of the Bombay Deccan and Karnatak.

24. The study of the black cotton soil under different manurial treatments.

R. D. REGE, Indore.

The plot culture experiments with jowar are conducted under the following treatments.

(1) Rab—burning of cowdung on the plot.
(2) Safflower cake 50 lbs. per guntha.
(3) Safflower cake 20 lbs. per guntha.
(4) Karanj cake 50 lbs. per guntha.
(5) Ammonium sulphate 12 lbs. per guntha.

Greater attention is paid to the physical effect of these manures on the soil. The following tentative conclusions have been arrived at :—

(1) The Rab process is not suitable to the tracts with low rainfall. It leads to rapid increase in the nitrification ; but the crop growth is not correspondingly increased. This treatment also decreases the colloid content of the soil, specially in the first four inches; but this result is only short lived. It disappears altogether after two months. The moisture determinations prove that this non-favourable effect of the Rab process is not due to the retention of less moisture in the plot as a result of the changed physical conditions.

(2) The safflower cake produces the best effect. There is not only vigorous growth of the plants, but this treatment leads also to early flowering and seeding. Water-logging of these plots for two to three days does not produce any bad effect on the crop. Extract of the

safflower cake which is very acidic brings about rapid settling of soil particles when added to the soil suspension.

(3) Weight for weight the effect of the karanj cake is less than half that of the safflower cake. The nitrogen content of the karanj is also about half that of the safflower and the difference in the plant growth may be attributed to this. The extract of the karanj cake is found to produce similar effect on the settling of the soil particles as that of the safflower cake, though this extract is far less acidic.

(4) Ammonium sulphate produces as good an effect as safflower if buffered well with lime.

(5) The water-logging of the control soil even for a day or two produces an immediate bad effect on the crop which, compared to that of other plots, is very poor. This bad effect of water-logging is not found to be due to either increased Co_2 content in the soil or decreased soil aeration. The nitrification in the soil is very little and the settling power of the soil particles extremely slow.

25. A simple method for the determination of assimilable pentosans.

R. D. REGE, Indore.

This is a continuation of an investigation published by the author (Annals of Applied Biology, Vol. XIV, 1927, 1). It is shown there that the "decomposibility" of a material is dependent upon the ratio of assimilable pentosans to lignin. The method proposed in that paper for the determination of pentosans is, however, lengthy and requires complicated apparatus which may not be available in all laboratories. An alternative simple method is therefore recommended depending upon the solubility of pentosans in caustic soda. A definite quantity of finely powdered material is treated in cold with 5 per cent. pure caustic soda for 24 hours with occasional shaking and the extract after neutralisation is distilled with Hydrochloric Acid by the usual Krober and Tollens' method. The comparison of this method with the original has given quite satisfactory results within the limit of 5 per cent.

26. A preliminary note on the successful treatment of the Jasmine bug—*Antestia cruciata*—by dusting calcium cyanide.

RAMACHANDRA RAO, Coimbatore.

Antestia cruciata—a pentatomid bug—was reported as a serious pest of jasmines in a flower garden in the neighbourhood of Bellary in December 1926. The bugs were found puncturing tender shoots and flower buds and causing them to wilt and wither. The aggregate loss sustained by the garden owner during a year was reported to amount to about Rs. 800. The bugs lay their eggs in clusters of 10 to 20 on the leaves and the inflorescences and the young ones grow by sucking the plant sap. It is, however, the adult bug that is mostly responsible for the damage done to the jasmines. As in a garden the owner has to cultivate different varieties of jasmine producing flowers at different times of the year, so as to be able to maintain a continuous supply to local markets at all seasons, the insect has an assured supply of plant food at all times of the year and is thus able to multiply enormously.

Dusting with calcium cyanide was found to have the effect of stupefying the bugs on the bushes and bringing them down to the ground. As a certain proportion of the bugs generally revived within a short time, these had to be handpicked and destroyed by dropping them in kerosenated water. To prevent the heavy consumption of the dust and the escape of bugs by flight during treatment, it was found, in the course

of the trials, more economical and effective to cover the bushes by a small tent of coarse cloth before pumping in the dust.

The experiments are being continued.

27. Casein making in Gujerat.

Zal R. Kothavala.

The paper deals with :—

I. Gujerat as a dairy district. II. Origin of casein making in Gujerat. III. Kinds of casein. IV. Process of casein making. V. Cost of manufacture. VI. Common adulterants used. VII. Field test for detecting adulteration. VIII. Points for judging casein. IX. Marketing. X. Uses of casein. XI. Scope for casein making.

28. Life history and control of *Tetroda histeroides* Fabr.

P. N. Krishna Ayyar.

The subject matter of this paper serves to illustrate how a comparatively harmless insect may, when favourable conditions such as an abundant and unfailing supply of food are afforded, multiply in such large numbers as to assume the role of a very destructive pest. A change in the system of cultivation recently adopted by the ryots of a village named Kattuputhur in Trichinopoly District led to an abnormal outbreak of *Tetroda histeroides* Fabr. in association with smaller numbers of *Scotinophara lurida* Burm. in July 1926 which threatened the total destruction of the standing paddy crop of the locality. An account of the nature and extent of the damage done by the pest is given as also details of a life-history studies of the insect. Notes regarding the history of this pest, its alternative host plants and the presence of two egg parasites are also included. Several measures were tried experimentally with a view to bring the pest under control and as a result certain practicable methods capable of recommendation to the ryots of the locality were devised.

Section of Mathematics and Physics.

President:—Dr. J. de Graaff Hunter, M.A., Sc.D., F.Inst.P.

Presidential Address.

Gentlemen,

1. The subject of my address to you to-day is a classical one, to wit "The Figure of the Earth." The shape and size of the earth on which we dwell has engaged the attention of scientists for more than 2,000 years. Progress throughout that period has been neither continuous nor rapid. The results of the Egyptian geometers were not seriously improved on until the 17th century. Between the time of Eratosthenes (B.C. 250) who considered the earth to be a sphere and estimated its radius at 7428 km. and that of Richard Norwood (A.D. 1637) who found the value 6412 km. for the radius, there were many years when orthodox persons considered the earth to be flat. The approximate mean radius is 6371 km. so that Erastothenes was too large by 17%: Richard Norwood erred in the same direction, but only by 2/3%. Thirty years later Jean Picard obtained a result almost identical with the modern value of the mean radius. The period during which enlightened people considered the earth to be a sphere and sought its radius thus lasted over 1900 years. The method employed was to measure the distance between two points on the same meridian, that is to say the length of a meridian arc: and to observe astronomically the latitude of each terminal point. From this the length of 1° of latitude could be deduced and the corresponding radius of the earth followed easily.

2. The earliest measure of meridian arcs, consisted in direct measure along the surface of the ground. Later on these measurements were replaced by triangulation emanating from a measured base. With the increase of accuracy due to better methods and better instruments it began to be recognised that the length of 1° of latitude was not the same at all places. Jean Richer (d. 1696) stated that the earth was not a sphere. This difference in arc length, however, was not very notable unless the two places were separated by a considerable amount in latitude. Such was the state of affairs in Newton's time. Newton had formulated his law of gravitation, and he came to the conclusion that the equilibrium form of a rotating gravitating fluid would be a spheroid. *i.e.*, a figure of revolution with an ellipse as meridian section. Moreover he said that this spheroid would be oblate, *i.e.*, the equatorial axis would be greater than the polar axis. He considered that the solid earth

would approximate to this form. Meantime the numerical results obtained by the French geodesists pointed to the earth's form being a prolate spheroid in which the polar axis is greater than the equatorial axis. The matter was not settled for a number of years. Expeditions were sent out, one to Finland, lat. 66° N. and another to Peru, lat. 2° S. The final results proved Newton's view to be correct.

3. By this time then the view prevailed that the earth was an oblate spheroid. This spheroid is defined when the equatorial and polar semi-axis a, c are given. Alternatively denoting the ellipticity or flattening by $f=\frac{a-c}{a}$; then the spheroid is specified if the values of the equatorial axis a and flattening f are stated. From 1750 onwards repeated determinations of these quantities were made, and in these many notable geodesists, among whom the French predominated, took part. Laplace in 1799 derived the value $a=6376{\cdot}34$, $1/f=312{\cdot}2$ in which a is 2 km. too small and $1/f$ is too large. It was at this time that serious observations began in India. Colonel William Lambton initiated high class triangulation in the Madras Presidency and worked at this until the time of his death at the age of 70 in 1823. His successor Sir George Everest was able to complete a meridian arc of triangulation from Cape Comorin at the south of India up to Banog in the Himalaya in the neighbourhood of Mussoorie. In 1830 he published the value derived from a portion of this work $a=6377{\cdot}276$, $1/f=300{\cdot}8$. Once more as in Laplace's case the a is too small but now by only 1 km. and the inverse of the flattening f too large. These values of Everest however have served as a satisfactory basis for the subsequent work of the Survey of India. Everest's values, though derived from observations in India only, were more accurate for the world as a whole than those of Laplace (30 years earlier) based on arcs in Peru, India, France, England, and Sweden: and also than those which Airy (the Astronomer Royal) found in the same year, 1830, from 14 arcs of meridian and 4 arcs of parallel. Then followed Bessel in 1841 with a very similar value and Clarke of the Ordinance Survey in 1857 who made a notable advance in precision. Clarke made redeterminations in 1866 and 1880 and these latter determinations have been widely used in surveys throughout the world. Mention must also be made of the determination by Pratt, Archdeacon of Calcutta, in 1863 which differed little from Clarke's values.

4. In the earlier days, up to say 1700, no very precise determinations could be made owing to lack of sufficiently accurate instruments. Improved instruments and more extended observations enabled the fact that the earth was not a sphere to be appreciated. Continued improvement enabled Everest and Pratt to approach more closely to the truth, and then

further complications were found to beset the problem. When the earth was thought of as a sphere it was not necessary to be very precise. Mountains and seas could be ignored. But later on it became important to state that by the figure of the earth was meant, not the actual surface of the globe, but the sea level surface. The actual surface which is now-a-days called the geoid may be defined in ocean areas as the mean water surface: whereby tidal fluctuations are disposed of. In land areas it is necessary to imagine the mean level at which the water would lie, if free connection with the ocean were provided. The object in view then is to find the form of the geoid: and the heights of mountains or depths of oceans are expressed with reference to the geoid, or mean sea level surface.

Newton stated that the form of a gravitating rotating fluid might be an oblate spheroid and he inferred that the earth would be of this form. But in this he did not consider in detail the effects of surface irregularities such as we may consider mountains and oceans to be. Other irregularities less apparent, are regions of the earth of abnormal density. When these are taken into account, it is clear that the spheroid of Newton will not in all likelihood represent the geoid absolutely. Everest found this to be the case and considered the geoid to be deformed in northern India by the gravitational attraction of the Himalaya. Accordingly when deducing his constants a, f, he used only a portion of his great meridian arc.

5. Meantime Archdeacon Pratt began calculating the effects of the Himalayan attraction. Observations of latitude were not available at many stations of the meridian arc: but where they existed they showed in Northern India a difference from the triangulated lätitude based on Everest's constants. These differences of latitudes found by star observations and triangulation are called "deviations of the vertical" or "plumb line deflections" and were attributed to "local attraction." Pratt found that the Himalayan attraction did not explain the deviations which observations had proved. According to his calculations the deviations should have been much greater than they were. This led Pratt to his theory of compensation which postulated that the density of matter underlying mountains was less than that underlying land at sea level. This idea has been developed on various different lines, Airy considering the crust of the earth to be in a sense floating on what was then believed to be molten matter, after the manner that icebergs float on the sea. The theory of isostasy as presented by Hayford in the 20th century states that the total mass in any vertical column of given cross section between the surface and the level of compensation, is constant at all places. In any case what is well established is that the form of the geoid does differ from that of the

spheroid : but not simply by what might be expected on account of topographic features. This does not prevent the study of the actual form of the geoid being continued, but adds interest to its continuance.

6. One of the primary interests in the investigation of the figure of the earth is provided by its entry into astronomy. Our knowledge of the scale of the universe depends fundamentally on the size of the earth. When it is stated that the solar parallax is 8″ it is implied that this is the angle subtended at the sun by the earth's radius, in terms of which the sun's distance is easily expressed. Other parallaxes depend in turn on the sun's distance from the earth. It is practically important for astronomers to know the distances between various observatories. Our knowledge of the earth's dimensions depends on investigations of the form of limited detached areas surveyed, supplemented by inferences as to the form of intermediate areas. In each of these detached areas the shape of the geoid can be found with a precision depending on the amount of observation data available. A spheroid may be selected which fits the geoid most closely in one region and it may be inferred with more or less confidence that this spheroid will also fit the geoid reasonably well in the regions, which have not been examined. Some uncertainty, however, remains. As an example it is to be pointed out that Newton's oblate spheroid is not the only equilibrium form of a rotating gravitating fluid. Jacobi showed that an ellipsoid with three unequal axis is a possible form of equilibrium : and several attempts have been made to apply this to the figure of the earth, with no very great success.

7. Any of the spheroids determined since and including Everest's provide a very convenient reference figure. The deviation of the vertical or the inclination of the normals to this spheroid and the geoid to one another at any point, indicates the relation of the two surfaces: and it becomes possible to trace the separation of the geoid from the spheroid when the deviation is known at an adequate number of places. This has been done in recent years for India, so far as present observation results admit—see Chart I. The contours on this chart give the geoidal rise above the Everest spheroid. It is a matter of geometry to work out the change in these contours if a different spheroid is employed for reference. In Chart II the geoidal contours are drawn with respect to that spheroid which fits India best. It will be seen that the geoid separates only 25 feet from this spheroid in the region dealt with. Himalayan areas, where data is inadequate, have been omitted : but it is clear that the separation there would be considerably greater. Were the geoid exactly an ellipsoid, the determination of the necessary quantities defining these surfaces would proceed to greater accuracy as the precision of observations improved.

We have, however, reached the stage when observation data is sufficiently precise to show that neither ellipsoid nor spheroid can be regarded as more than approximations to the geoid. Inevitably then the fit of geoid and spheroid in a particular region is not perfect.

8. The method in vogue for over a century has been to take arcs of meridian and parallel in various parts of the globe and to derive therefrom the constants of spheroid or ellipsoid which fit these various arcs best on the whole. In this way none of the arcs are fitted exactly, and the discrepancies may be attributed to "local attraction." I consider this a most unsuitable term; it really should imply anomalies of attraction due to anomalies of density throughout the globe, not only local.

The anomalies of density could not be inferred with certainty even if we had explored the whole of the geoid and observation was faultless; for the interior of the globe may be varied in an infinity of ways without affecting the size and shape of the geoid. However hypotheses may be framed which will perhaps allow reasonable deductions to be made as to the distribution of density anomaly.

9. Hayford in 1909 applied the hypothesis of isostasy to the problem. In this hypothesis it is stated that the total amount of matter in a column of unit cross section, extending from a certain level up to the earth's surface is constant. This level is called the level of compensation and Hayford estimated its depth as about 70 miles below sea level. The hypothesis implies that below a mountain there is a compensating deficiency of density down to a depth of 70 miles: while below the sea there is compensating excess density. It is possible to compute the attraction effect of all topography and its compensation on this hypothesis and such computation should explain the deviation of the vertical observed to occur, provided (1) that the hypothesis is correct and (2) that the proper reference spheroid (or ellipsoid) has been employed. By means of this hypothesis Hayford made a determination of the constants of the spheroid which best fitted the U.S. observations after topographic compensation had been allowed for. The values found by Hayford from observations in U.S. only were adopted in 1924 as the international spheroid by the International Union of Geodesy and Geophysics, assembled at Madrid. It implies great confidence in Hayford's hypothesis of isostasy. The wisdom of the choice was not admitted by all concerned.

10. The probability of a hypothesis being correct or not depends among other things on the success it attains in explaining the observational facts: but in some cases even if these facts are fitted exactly, this is not complete *proof* that the hypothesis is correct. Consider a very simplified imaginary

problem of the same nature as our general problem of the earth. Let us imagine that the earth were composed of ordinary gravitating matter, but was not rotating: and that it was found by measurement to be an exact sphere, with gravity of known constant value over its surface. Such a state of affairs would exist if it was composed of matter of uniform density throughout of total mass M. But it will also exist if the density was constant for any particular depth and different for different depths, provided that the total matter had the mass M. The attractional effects of a sphere of uniform density at its surface and at all points outside are the same as though the whole mass were concentrated at the centre. Further any spherical volume of uniform density within the earth can be replaced so far as outward effects go by many different distributions of density. The moment we have found a distribution of density which will explain the external effects, we can proceed to modify this distribution in an infinity of ways, and the external effects will remain unchanged. Some of these distributions might involve such extreme values of density—high or low—that to many minds they would appear ridiculous. But even avoiding such extremes there are still left an infinite number of distributions of density between which surface measurements of shape cannot discriminate. This applies equally to the more complex case of the actual earth, to which we may now revert. Recourse must be had to other considerations than the surface measurements of the surveyor and astronomer. The old ideas of an earth with a molten interior made this problem much simpler: for in a molten earth the laws of hydrostatics must be satisfied. It used to be customary to speak of the earth's crust, by which was meant the outer solid skin within which all was fluid. The term is still used, but it has now lost its precise significance since the belief in a molten interior has been adandoned. It may still conveniently be considered to mean the outer shell of the earth, down to some convenient depth, such as 70 miles—the depth of Hayford's compensation level.

11. I think it is generally believed that in ages past the earth was molten, and that it has since become solid: and starting from this we may look on it as being in a state approximating to one of hydrostatic equilibrium. From the time of its solidification, surface changes have occurred which introduced stresses of a non-hydrostatic nature. Such stresses have been resisted by the strength of the earth's material. In cases where this strength has not been sufficient some form of yielding must have occurred until the stresses were sufficiently reduced. It is difficult to form definite quantitative conclusions. We do not know the materials of which the inner earth is composed nor their strength characteristics in any detail. The immense pressure which must exist in the interior

can hardly be produced in the laboratory, nor is it possible to extend tests over immense time intervals such as have occurred in the formation of the earth as it is. This much at least is known, that many substances—marble is an example —when subjected to great forces, long continued, can change shape without fracture. One may think then of solid matter under such conditions as have obtained within the earth, behaving as quasi-fluids—changing shape and flowing slowly in response to stresses which have arisen. In fact one is driven to feel that this must have occurred in regions where the pressure is very great, that is to say, at considerable depths. Such ideas are not in contradiction of the ascertained facts of the rigidity of the earth as a whole, shown by its resistance to tidal forces to be of the same order as that of steel. The transmission of earthquake waves through the earth throws some further light on the average internal condition, which does not clash with these other conceptions.

12. Accordingly it seems a reasonable hypothesis to consider the earth as in a state of quasi-hydrostatical equilibrium in its interior, and further to consider that in the crust there are deviations from such a state. This latter indeed we must do, for the existence of topographic features—high mountains and deep oceans—proves it without doubt. It is a matter of difficulty even so to decide the thickness of this crust or density anomaly, and the relation of such anomalies to the topography of the surface. Hayford's hypothesis of isostatic compensation, complete in a depth of 70 miles and uniformly distributed along any vertical, is an attempt to deal with this. If then this hypothesis meets, or goes far to meet, all the observed surface effects, one might reasonably feel some confidence in its truth.

13. So far we have been considering the work of the geodesist who measures distances on the ground and computes therefrom, on some selected figure of reference, the geodetic value of latitude and longitude. This he proceeds to compare with latitude and longitude determined by astronomical observations and from the discrepancies found he modifies his reference figure to make the discrepancies as small as possible, in some cases bringing in an hypothesis such as Hayford's to reduce still further the discrepancies. Finally he is forced to assume that the reference figure thus arrived at is the best representation he can get for the whole globe. If his figure of reference is a spheroid he defines it by the length of the major axis ($2a$) and the flattening (f).

The geodesist has also another method for finding f, depending on the measurement of the force of gravity. In this way also the basic assumption that the earth is a spheroid, or nearly so, is employed.

14. There are other independent methods of estimating

the flattening f, based on the assumption that the earth is of spheroidal form. I will only mention these without attempting to describe them in any way. Lunar motion, lunar parallax and precession all involve the flattening f, and thereby values of f have been obtained. Some of these are exhibited in the Table I. It will be seen that the values of $1/f$ found by these means are in the main smaller than those found by geodetic means, subsequent to Clarke's determination.

15. During the last few years I have been considering the matter in a somewhat novel manner. The data employed are the same as those already used by geodesists, viz., the differences found between geodetic and astronomic values of latitude and longitude—what is ordinarily called the "deflection of the plumb-line" or the "deviation of the vertical." Instead of using arcs of longitude and meridian I have employed the deflections to trace the separation of the spheroid of reference and the actual geoid. In principle this is very easy. The deflections are the actual inclinations of the two surfaces, and so, if known at a sufficiency of points, enable the separation to be computed. The result is shown in chart I, in which the rise of the geoid with regard to Everest's spheroid is indicated by contour lines, the contour interval being 5 feet. The geoid there shown is the actual level, with reference to the spheroid of Everest, at which the sea would rest, if admitted to land areas. It is based purely on measurements and involves no assumptions. It is quite simple to find how these contours would be modified, if referred to a different reference figure—that is only a matter of geometry. To define a spheroid it is sufficient to state the value of the two quantities semi-axis (a) and flattening (f). But it is further necessary to locate the spheroid: and for this three quantities—the co-ordinates of any point in it—suffice. The direction of its polar axis is known within the limit of observation error. There are accordingly five quantities at choice with an alternative spheroid. These can be selected with a view to arriving at a reference figure which best fits the actual geoid. The result, that is to say the contours of the geoid exhibited with respect to this best fitting spheroid, is shown in chart II. In this the contours lie within a range of 50 feet which may be compared with a range of 220 feet in the case of Everest's spheroid. The value of a is actually larger and of $1/f$ is smaller than all previous values: vide Table I.

16. This is the spheroid which fits India most closely. How far it is likely to fit the rest of the globe is another affair. At present the form of the geoid has not been worked out in all surveys. The U.S.C.& G.S., however, published in 1909 (the Figure of the Earth and Isostasy from measurements in the U.S.) a chart showing the form of the geoid in that country. The spheroid which fits the geoid in U.S.A. best has been derived in India, with result shown in the table as Solution III. Here

again there is a small value of $1/f$: but the value of a differs by 1/20,000 from that found from the Indian geoid and is the smallest found since Bessel. This shows that precisely the same spheroid does not suit India and the States. As representing the whole globe, however, something between the two may be fairly good. Taking the simple means we get a result a 6378·368, $1/f$ 293·0 which is not very different from that of Clarke's III. It may be noted that an error of 64 meters is but 1 in 10^5 in a, an accuracy higher than the average of the best triangulation. However, the difference between the Indian and the U.S. spheroids just determined is sufficiently great (1 in 20,000) to have reality. The latitude limits in the two countries do not overlap. They are 8°–30° for India and 30°–50° for the States. Taken together the two portions of the geoid could be better fitted either by

(1) using a three axial ellipsoid,
or (2) using a figure of revolution whose meridian was not an ellipse.

17. Now let us consider the question on Hayford's hypothesis. It is not difficult to calculate on this hypothesis, how much the geoid will rise at a point as a result of compensated topography. This has been done at a number of comparison points and the solution for the best fitting spheroid taken out as before, for both the Indian and the American geoid. The results, given in the table at II and IV, are rather interesting. So far as India is concerned the change is very small, increasing the semi-major axis by 33 meters and making no change in the flattening. The residuals of this solution, however, are greater than those of I, indicating that the hypothesis of isostasy carried to this detail has not explained the residuals at all. In the case of the States the result is widely different. As might be expected a result very similar to what Hayford found is obtained—the differences are merely due to the different method of computation. The semi-major axis is now increased as compared with Solution III, the flattening becomes 1/297·3, and the residuals have been markedly reduced. In this area—the States—the hypothesis of compensation may be considered to have gone some way to explain the form of the geoid. However it appears doubtful to me whether the spheroid thus derived is to be regarded as a better, or even as good, an approximation to the whole earth, as that found in the solution without the compensation hypothesis. The two uncompensated solutions are rather more accordant than the two compensated ones. If Hayford's compensation is true it should reduce the geoid at all portions to the *same* spheroid. It actually gives values of $1/f$ differing by 5 units in India and the States. The uncompensated solution while showing a variation of 295 meters in a (1 in 20,000) as against 182 meters occurring in the compensated solution, has a variation of

only 1·2 in the flattening: and so makes the hypothesis of one spheroid for the whole earth more probable.

18. That Hayford's hypothesis is not true in detail all over the earth is indicated in Solution II. The anomalies which exist from true compensation in India have been worked out and are indicated by a set of curves in chart VII. The unit employed in this chart is chosen to make convenient a comparison with anomalies in g found by the pendulum. In chart IX are exhibited the anomalies found by pendulum observations in the value of g expressed in dynes. The previous chart VII shows the anomalies which would have been anticipated from the derived geoidal form. The results are not quite truly comparable, in that the observed gravity residuals are derived from a formula for gravity (Helmerts, 1911) which implies a rather different value of the flattening from that adopted for the geoidal results. Moreover, the term ·011 is arbitrarily derived for India. The necessary computations to remove these discrepancies will be taken up shortly.

In addition to this the gravity results are rather too scant to allow of the curves being drawn with great certainty. However, they have been drawn entirely independently by Major Glennie, before chart VII was thought of. There is certainly some degree of accord between the two charts, which may improve with fuller information and after employ of the same value of the flattening in both cases. It is not to be expected that the curves should be precisely the same. Those of chart VII derived from the geoid are generalised: while the others are based on individual values which may have considerable anomalies due to purely local density anomalies. It is in them that I see a possible practical utility in pendulum observations, for detecting such local anomalies. Hitherto the anomaly as found included a portion due to more distant causes. With our geoidal deduction we can eliminate these. I may say in passing that a reference figure is needed for gravity consideration just as much as for deflections. For this it is desirable to specify that the spheroid selected is a level surface of the ideal density distribution which we elect to consider normal. To this we can easily add consideration of topography, and its compensation too if desired.

19. To me it appears natural that the astronomical methods, based on lunar motion, parallax and precession are most reliable for finding a *generalised* value of the flattening of the spheroid best fitting the whole earth. The probable errors of the determination from the geoid are considerable—in the flattening about 1·5 for India and 1·0 for the States. In the compensated solution the States solution has a smaller p.e.: in the Indian compensated solution the p.e. is increased. These p.e.'s are not concerned with errors of observation: they are derived from the residuals between geoid and spheroid, which are actualities.

The p.e.'s may be reduced when larger areas are considered or possibly they will not be. Really they give a measure of the success of a spheroid in representing a figure not truly spheroidal. The deviations from spheroidal form do not suggest that any other single figure would do any better than the spheroid. But doubt arises when one strives to extend a spheroid derived from one locality, which it does not fit perfectly, to geodetically unexplored regions of the earth.

20. It appears to me that we have pressed the spheroid about as far as can be done with profit. So far as results derived from principle triangulation can go, we cannot expect to get a result better than 1 in 10^5, i e. 64 meters in a and one unit in the flattening. The difference of geoid from the selected spheroid cannot be explained on the whole by Hayford's compensation : and so the fundamental fact emerges that the spheroid is but an approximation. Just as it became fruitless to continue evaluating the earth's radius with increasing precision, when measures were able to distinguish between the lengths of the two semi-axes; now with further advance of precision we can do no more with the spheroid.

For some purposes it is sufficient to think of the earth as a sphere ; for others as a spheroid. But for detailed study of its form and anomalies we have to recognise that the spheroid can only be considered as a reference figure from which the geoid deviates. As a figure of reference it is sufficient to select a spheroid good to the nearest 100 meters in a and one unit in $1/f$: and I incline to the value 1/295 as about the best compromise among the various values found for f. Such a figure would serve astronomical purposes well. For geodetic needs and studies of crustal anomalies either the same or the best local spheroid might be used.

TABLE I.

Values of a and f found from triangulation.

Year.	Author.	a in km.	$1/f$.	Data and hypothesis.
1799	Laplace.	6376·34	312·2	Peru, England, France and Sweden.
1830	Everest.	6377·276	300·80	Indian arc only.
1830	Airy.	6·542	299·33	14 meridian and 4 parallel arcs.
1841	Bessel.	7·397	299·15	10 meridian arcs.
1863	Pratt.	8·297	295·26	Anglo-Gallic, Russian and Indian arcs.
1857	Clarke I.	8·345	294·26	Anglo-Gallic, Russian, Indian, Prussian, Peruvian, Hanoverian, Danish.

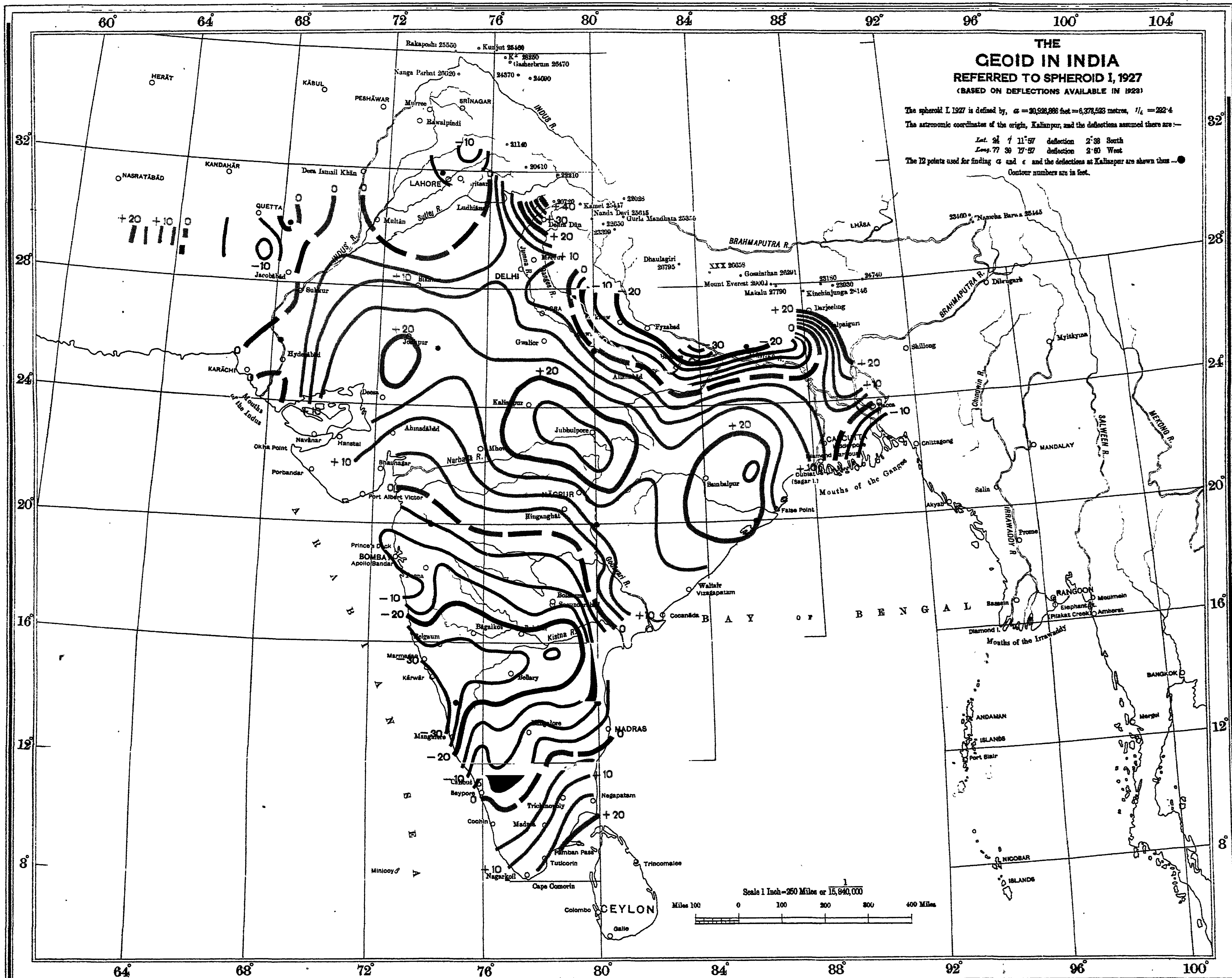
Year.	Author.	a in km.	$1/f$.	Data and hypothesis.
1860	Clarke II.	6378·258	294·98	Anglo-Gallic, 2nd Indian, Russian, Peruvian, Cape.
1880	,, III.	8·301	293·47	Above reconsidered.
1909	Hayford.	8·388	297 0 ± ·5	U.S. only on basis of isostatic compensation.
1927	Surv. of I I.	8·508	292·4	Geoid in India only.
1927	,, II.	8 541	292·4	Geoid in India with isostatic compensation.
1927	,, III.	8·213	293·6	Geoid in U.S. only.
1927	,, IV.	8·359	297·3	Geoid in U.S. with isostatic compensation.
1927	,, $\frac{\text{I}+\text{III}}{2}$.	8·368	293·0	Geoid in India and U.S.

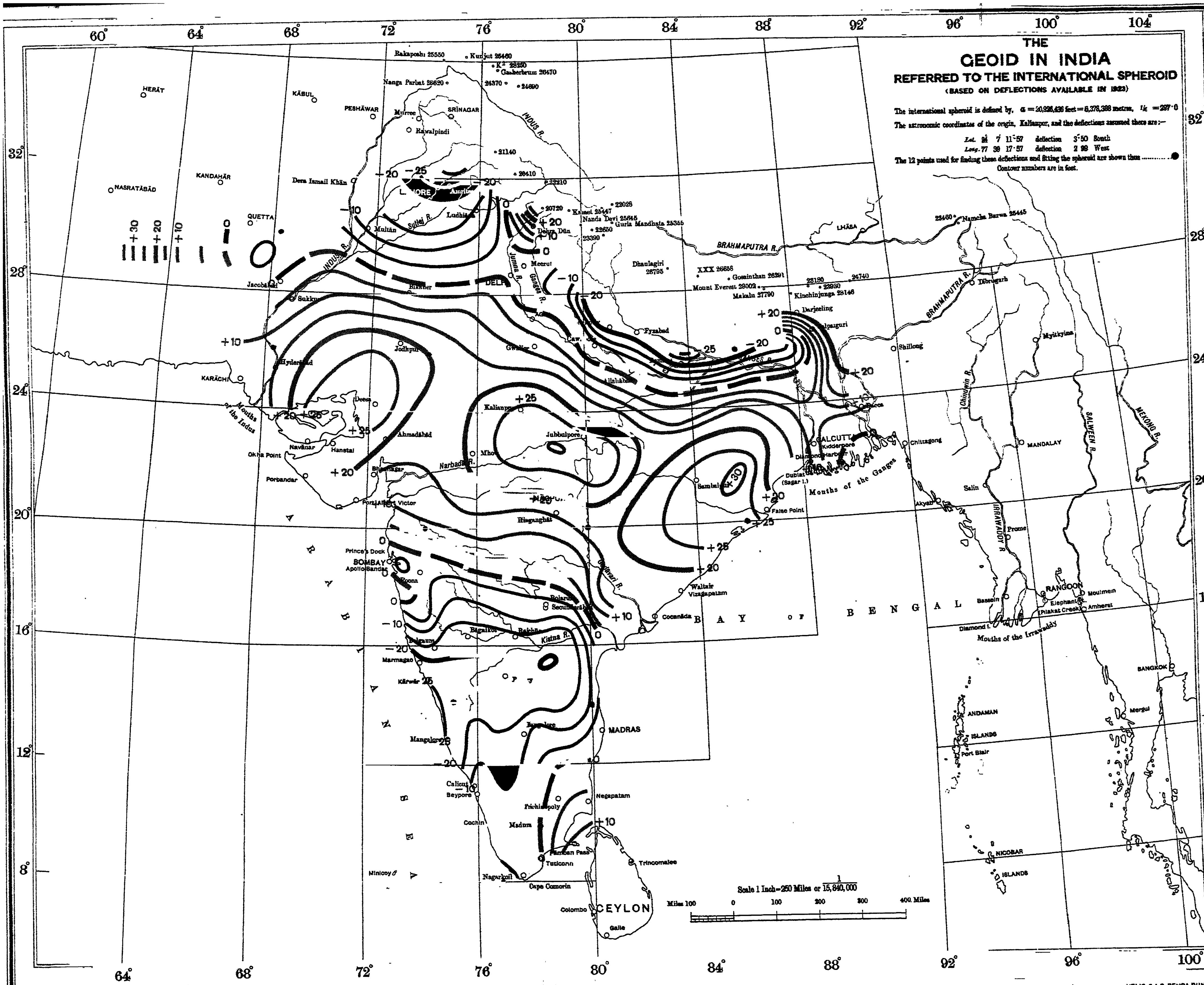
Values of f from pendulum results and corresponding factors in formula for $g = G\{1 + A \sin^2\phi - B \sin^2 2\phi + C \cos^2\phi \cos 2(\lambda - \lambda_0)\}$.

Year.	Author.	$1/f$.	G.	10^6A.	10^6B.	10^6C.	λ_0 (+ve when E).
1911	Helmert I.	298·3	978·030	5302	7	0	..
1915	do. II.	296·7 ± 0·4	978·052	5285	7	18 ± 4	17° ± 6 W.
1917	Bowie.	297·4 ± 1·0	978·039	5294	7	0	..
1924	Heiskanen.	294·3 in 18°E.	978·052	5285 ± 6	7	27 ± 3	18° ± 5°E.
		299·0 in 72°W.	This implies a difference of 345 m. in semi-equatorial axes. The major axis is in longitude 18°E.				

Values of f from lunar observations.

Year.	Author.	$1/f$.	Method.
1899	Darwin.	296·4	Precession.
1914	Brown.	293·7	Lunar theory.
1914	Crommelin.	294·4	Moon's parallax.
1924	Spencer Jones.	294·8 ± ·2	Moon's perigee.
		294·9 ± ·3	Moon's node.
1927	de Sitter.	296·92 ± ·14	General.


THE
GEOID IN INDIA
REFERRED TO SPHEROID I, 1927
(BASED ON DEFLECTIONS AVAILABLE IN 1923)
The spheroid I. 1927 is defined by, a = 20,926,886 feet = 6,378,523 metres, 1/ε = 292·4
The astronomic coordinates of the origin, Kalianpur, and the deflections assumed there are :—
Lat. 24° 7′ 11″·57 deflection 2″·38 South
Long. 77 39 17·57 deflection 2·60 West
The 12 points used for finding a and ε and the deflections at Kalianpur are shown thus ...
Contour numbers are in feet.
Scale 1 Inch = 250 Miles or 1/15,840,000
Miles 100 0 100 200 300 400 Miles
BAY OF BENGAL
ARABIAN SEA
CEYLON
ANDAMAN ISLANDS
NICOBAR ISLANDS
BRAHMAPUTRA R.
INDUS R.
Mouths of the Ganges
Mouths of the Indus
Mouths of the Irrawaddy
DELHI
LAHORE
BOMBAY
CALCUTTA
MADRAS
RANGOON
KARACHI
QUETTA
HERAT
KABUL
KANDAHAR
PESHAWAR
SRINAGAR
LHASA
MANDALAY
BANGKOK
Kalianpur
Jubbulpore
Nagpur
Hyderabad
Jodhpur
Gwalior
Ahmadabad
Sambalpur
Bellary
Madura
Cape Comorin
Colombo
Trincomalee
Mount Everest 29002
Kinchinjunga 28146
Dhaulagiri 26795
Nanga Parbat 26620
Gasherbrum 26470
Rakaposhi 25550
Namcha Barwa 25445
60° 64° 68° 72° 76° 80° 84° 88° 92° 96° 100° 104°
32° 28° 24° 20° 16° 12° 8°



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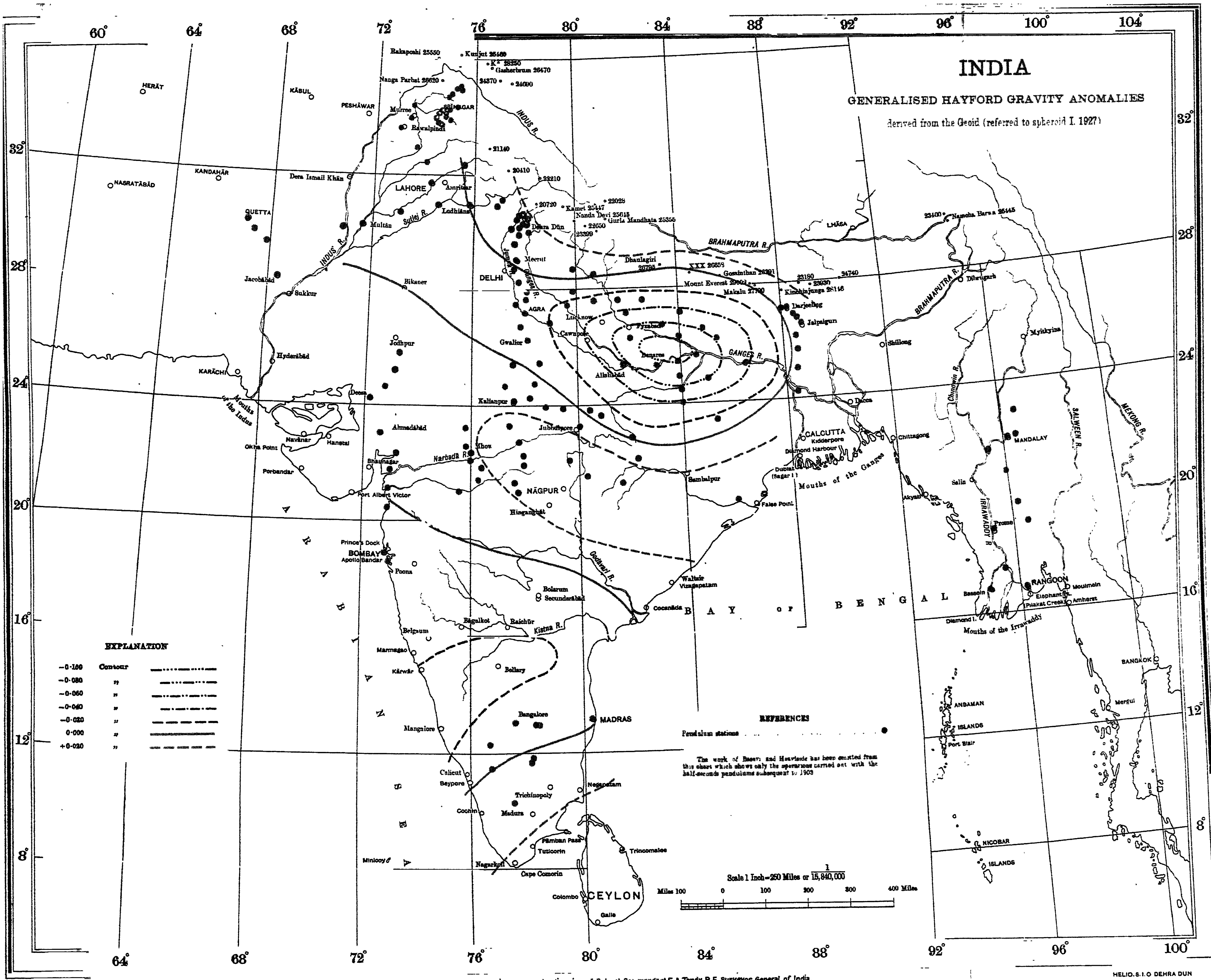

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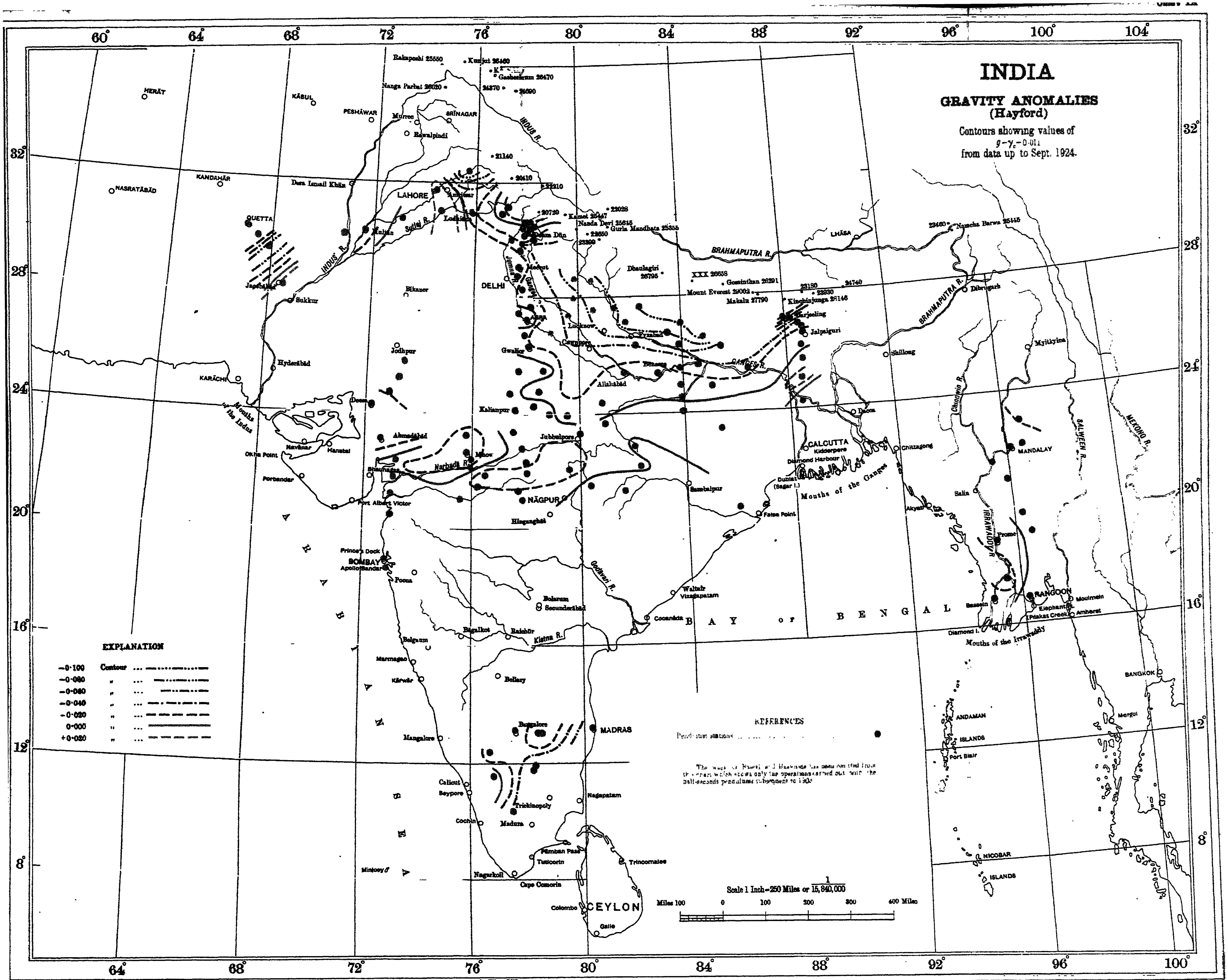


HELIO & L.O DEHRA DŪN

Section of Mathematics and Physics.

Abstracts.

1. Experimental harmonic motion—Part III—Bifilar pendulum for determination of 'g'.

S. Genapatisubramanyam, Rajahmundry.

The writer has described some experiments on harmonic motions in the thirteenth and fourteenth sessions. A new and simple method of using the bifilar pendulum for evaluating the value of 'g' (to be published shortly in the Journal of Scientific Instruments) is described. The method is susceptible of giving closer values than those derived from many approximate methods described in various books.

2. Steady Vortex motion of a liquid within fixed boundaries.

B. M. Sen, Calcutta.

The rotational motion of a liquid in the presence of a free cylinder and a sphere have been solved by Proudman and Grace. (Proc. Roy. Soc. 1916-22). The present paper seeks to determine vortex motions in liquids in the presence of fixed solids which are either internal or external boundaries. Adopting Clebsch's method of representing the velocity of a liquid, it has been shown that the two-dimensional motion can be made to depend on the partial diffl. equation of the second order,

$$(t-r)(q^2-p^2)+4\,pqs=0$$

which possesses two intermediary integrals.

Again it can be reduced to an "eigenwert" problem. The stream function ψ satisfies the equation

$$\nabla_1^2\psi+f(\psi)=0$$

where f is an arbitrary function. This can be solved for particular values of f giving corresponding boundaries.

The case of three-dimensional motion with parallel vortex lines of constant strength, can be made to depend on the same diffl. equation. The velocity in the direction of the vortex lines must be of the form $Az+B$. As simple particular cases, the velocities

$$u=-y,\ v=x$$

lead to the surface

$$\frac{z}{B}=\tan^{-1}\frac{y}{x}+f(r) \text{ if } A=0$$

or $Az+B=F(r)e^{A\theta}$ if A is not zero.

3. Thunderstorms of Calcutta. 1900-1926.

V. V. Sohoni, Calcutta.

Thunderstorms and "nor-westers" of south Bengal, are striking phenomena. Some of them cause damage like that by tornadoes. Alipore Observatory records for 1900-1926, for some 500 thunderstorms were examined.

Largest number of thunderstorms occur in May; on an average 6:

similarly 5 in April. In September, at the close of the southwest monsoon, there is a slight tendency again of a secondary maximum. Most usual time of occurrence is between 5 and 8 p.m. About 26 m. p. h. is the most common value of maximum wind velocity. Only two instances of velocity exceeding 60 m. p. h. are on record. At the onset of the squall, wind direction, which before is southerly, shifts suddenly to W. or NW. Thunderstorms are mostly accompanied by a sharp fall in air temperature. The most common drop is 6°; there are instances of falls of 20°. In very few cases rise was recorded; these were rainless storms.

Humidity changes are variable. Rainfall of a thunderstorm may be anything from a few cents to a few inches; occasionally very intense. Hail occurs only 5 times out of 200.

Pressure rises on an average about 0·07 in. in a thunderstorm.

Typical records of automatic instruments and curves are given.

4. An improved form of lamp resistance board for simultaneously charging storage batteries of widely different capacities.

ABINAS CHANDRA SAHA, Rajshahi.

The chief merit of the arrangement lies in the fact that a portion of the electrical energy, which is ordinarily allowed to be dissipated as heat and light while charging a battery of storage cells, is utilised in charging another battery of smaller capacity. The latter is charged without any additional expenditure of energy from the source.

The battery of smaller capacity is connected, through a suitable resistance, in parallel with the system of lamp resistances which is placed in series with the battery of larger capacity.

Small batteries of storage cells are now a days largely used in wireless receiving sets. These can be frequently charged with the help of such a charging board in a laboratory (at the time of charging larger cells) without any extra cost.

5. New bands in the secondary spectrum of Hydrogen.

D. B. DEODHAR.

The present paper deals with a system of six new bands in the secondary spectrum of Hydrogen situated in the yellow region of the Spectrum. The development of these band lines is made by studying the behaviour of the spectrum due to condensed discharge and due to the impact of slow electrons under low pressure conditions. The P branches of all the six bands are fairly stray and the properties of the lines show that a majority of them are either condensed discharge lines or else they do not possess any special character.

The P_2 lines of all the bands are separated by about 150 wave numbers. The first differences of the P and R branches steadily increase while those of the branches decrease as we go from the 1st band to the 6th band. All the associated P, Q, R branches obey the usual combination principle such as $Q(m+1)+Q(m)=P(m+1)+R(m)$.

The initial moment of inertia is greater than the final for all the bands; and the values go on decreasing from $9{\cdot}36\times10^{-41}$ gm $\times$ cm^2 for the first band to $5{\cdot}55\times10^{-41}$ gm$\times$cm^2 for the last band. The values of the final moment of inertia also decrease gradually from $7{\cdot}99\times10^{-41}$ gm$\times$cm^2 to $5{\cdot}25\times10^{-41}$ gm$\times$cm^2. The order of the values is the same as recently found by Richardson for a system of Fulcher bands. This fact coupled with the recent discussion by Van Vleck on the moment of inertia of neutral H_2 molecule leads to believe that the emitter of these bands is an excited H_2 molecule.

A similar system appears to be present in the blue region and the matter is being further investigated.

6. The density of the vapour in a Mercury arc and the relative intensities of the radiated spectral lines.

B. VENKATESACHAR, Bangalore.

The question of the relative intensities of spectral lines has assumed importance in view of recent theoretical developments. In the case of electrical excitation various factors influence line intensities; and the problem of isolating the effect of any one is one of no small experimental difficulty. The writer has described experiments in a paper (Proc. Roy. Soc. in press) showing the large influence of the density of the vapour on spectral intensities in the radiation from a mercury arc discharge, other conditions of excitation being kept unaltered. The present paper deals with a photographic study of the gradual variation in relative intensities of the lines in the region 2100 to 1850, as the density of the vapour is varied. The bearing of the result on the theory of spectral radiation is discussed.

7. A low density Cadmium vapour lamp.

B. VENKATESACHAR, Bangalore.

In the case of mercury the pressure of the vapour ranged between $2mm$ and $\cdot 1mm$. To realise similar conditions in cadmium arc discharge a cadmium lamp with a hot *solid* cadmium cathode and a water cooled Cd-anode was designed. A study of the photographs confirms the results obtained with mercury. Particularly striking is the appearance of the higher members of series lines and of the so called 'forbidden lines' at a pressure of about $2mm$ of Hg.

8. Note on the simple periodic motion.

SATYENDRA RAY.

The solution of *eqn*

$$\frac{d^2y}{dt^2} = -\mu^2 y$$

is given as a periodic motion of period $\frac{2\pi}{\mu}$. Writing the *eqn* in the form

$$\frac{d^2y}{dt^2} = -(n\mu_n{}^2)y,$$

the simple periodic motion $y = na \sin \mu_n t$ of period $\frac{2\pi}{\mu_n}$ can be seen to satisfy the physical condition of an S. H. M. viz.,

$$\frac{d^2y}{dt^2} = -\mu^2 y$$

Therefore, along with the period of

$$\frac{2\pi}{\mu} = \nu. \ ,$$

other periods are possible given by the relation

$$\frac{\nu.}{\sqrt{n}} = \nu_n \ .$$

Again as energy is proportional to the square of the product of a and ν

$$n^2a^2\nu_n{}^2 = na^2\nu.^2$$

where n is an integer. The energy of the vibrating particle is therefore atomic in structure.

9. On the imaginary character of the "mass equivalance of electricity."

SATYENDRA RAY.

(*a*) The electron "field" exists in the medium and radius of the electron really defines the boundary of a spherical volume inside which the field is assumed not to exist. (Cf. Millikan's Electron, Appendix D.) The "radius" of the electron is therefore not identical with the radius, say of a billiard ball. The electron exists from infinity up to the radius but not inside the radius, while the billiard ball is supposed to exist from $r=o$ to $r=a$, and not beyond the last limit. Besides, the difficulty of imagining a sudden boundary to the field at a surface where energy per unit volume is a maximum is very great if a material wall is not to be thought of.

(*b*) It is submitted that the mass equivalent of electricity should be obtainable by substituting masses proportional to the charges subject to the condition that the same forces after substitution should obtain as before it. For simplicity, in case where the two charges are equal we obtain

$$G\frac{m^2}{d^2}=F=-K\frac{e^2}{d^2}$$

where K is the reciprocal of the sp. inductive capacity. Therefore we have

$$Gm^2=-Ke^2$$

or

$$m=\sqrt{-\frac{K}{G}}e.$$

This view point communicated to Prof. Wolfers has been referred to in some of his writings.

10. A generalisation of the Virial of Clausius.

SATYENDRA RAY.

Maxwell pointed out the possibility of explaining Boyle's Law from a force of repulsion between molecules only, instead of from motion of moving particles from the equation

$$pv=\tfrac{1}{3}\Sigma mc^2+\tfrac{1}{3}\Sigma\Sigma r\phi(r)\ldots.(\mathrm{i})$$

Jeans discusses the possibility and declares it impossible owing to the uniformity of pressure within a volume being directly in contradiction to the results indicated by a law of the form

$$\phi(r)=\frac{K}{r}\ .$$

It is submitted that the uniformity is only "assumed" to exist, and the expression i is obtained by Jeans under this assumption. Also the indication from the law

$$\phi(r)=\frac{K}{r}$$

will, *a fortiori*, hold good for the "inverse fifth power law" assumed by Jeans himself elsewhere.

The investigation is remade, without any "assumption" regarding uniformity of pressure inside a volume, and it is shown a variation of pressure with distance from the walls is not incompatible with Boyle's law, the average pressure being defined by the expression

$$\iiint p\,dxdy\,dz=\Pi\cdot v.$$

11. Note on the discharge of an electroscope.

SATYENDRA RAY.

(Copies of paper handed to Prof. A. H. Compton, and sent to Dr. W. Kolhörster in Feb. 1927.) It is shown that the discrepancies between the results of Millikan and Kolhörster can be completely explained if we remember that the potential of the enclosure is varying with height during ascent and descent according to an experimental law submitted by the author to I. S. C. Benares (Zeit. f Phy. 33, 48–52, 643–645).

12. A note on the Compton effect.

SATYENDRA RAY.

It is submitted that the effect is only a doubling—or tripling ?—of some lines in the X-ray region. They have analogues in other wavelength regions *e.g.* in "Un nouveau phenomene en optique (Journal de Physique VI. 305 and 354), and the earlier work of Rubens on "Rest strahlen." An expression similar in form to that of Compton is given from a theory of photoelectric phenomena given by the author in Zeit. f. Phys. 33, 231–236.

13. A note on isotopes.

SATYENDRA RAY.

The isotopes are based on what may be called the "fine structure of mass spectra." Attention is drawn to the very photographic similarity between the optical and mass spectra which even a superficial examination of Aston's photographs reveals. As a variation of 1 in 200 in the value of (e/m) is all we get, and as Daecke in his articles in Phil. Mag. and Zeit. f. Phys. maintains that e is 1/19 of its accepted value, it is submitted that the proper interpretation of Aston's results is that e is 1/200 of its accepted value or about 1/10 of that accepted by Daecke.

14. Avogadro's number and electronic charge.

SATYENDRA RAY.

One method of finding e is to find Ne and then dividing the quantity by N. If the Avogadro's number be much higher than we take it to be (Zeit. f. Phys. Chemie 128, 182–88) the value of e determined by this method at least will immediately go down.

15. Theoretical and empirical formulæ in rotation spectra.

SATYENDRA RAY.

The table for rotation spectra from Lewis's Quantum theory is taken and two tables are given, one theoretical and the other empirical showing better agreement with experiment than the tables of Bohr., Bjerrum and von Bahr.

16. The fine structure constant as equal to $(1/4\pi)^2$.

SATYENDRA RAY.

From Jeans' report on radiation (page 80) and Sommerfeld it is shown that the fine structure constant is a numerical constant.

17. On Fourier analysis subject to the condition of "geometrical similarity" of the harmonics.

NALINI N. BOSE, Lucknow.

(Communicated by Satyendra Ray.)

In Ben: Math: Soc. Proceedings Vol. VI. 1924 Ray has proved the failure of ordinary Fourier analysis for strings and air columns and mentioned the need of an analysis where the ratio of amplitude and wavelength is kept constant, the curves being shifted by an amount corresponding to a phase difference from the fundamental in order to give us the required agreement. This analysis is supplied, a simple expression for the phase angle of each harmonic being obtained.

18. Lommel's analysis and continuous spectra.

NALINI N. BOSE, Lucknow.

(Communicated by Satyendra Ray.)

Spectra are of three kinds in general, the primary line spectra, the secondary line spectra and the continuous spectra. The first is supposed to be explained by Bohr's hypothesis, the second is a little more difficult to explain, and experimental data are far from complete; e.g. for the simple element H alone Deodhar has recently found as many as 450 *new* lines. If Ray's hypothesis of explaining them from Fourier's analysis be accepted, the constancy of "second differences" found in Deodhar's experiments indicates the existence of more than twice the lines still remaining undetected. The continuous spectrum is still unexplained. This can be explained by resorting to Lommel's analysis which is capable of giving a continuous train of waves corresponding to a monochromatic radiation. The "flat tuning" met with in wireless telegraphy is also thus explained.

19. On the variation of wavelength parallel to the length and along a diameter of the cross section of a Cooper Hewit mercury lamp.

S. K. DUTT and S. S. SHARMA.

Light was made incident by reflection on a spectrometer slit by a mirror capable of rotating about two axes at right angles to each other. The spectrum was examined by a reflexion grating. A distinct variation in the value of wavelength was noticed both when the mirror was rotated so as to send the light from different points along its length as also when rotated so as to send light from different points of a transverse cross section.

20. On the theory of consonance of Helmholtz.

N. N. IENGER.

Attention is drawn to the arbitrary assumption of Helmholtz of dissonance being maximum with 33 beats per sec. Also to the absence of mathematical discussion of beats except when the notes are nearly in unison or very nearly a harmonic of the other. Helmholtz in App. XIV has shown clearly, first, that the resultant note varies firstly in amplitude, and, secondly, in pitch, with time, the range of pitch variation depending upon the amplitudes of the two notes. In other words, the compound

note is not periodic in any sense of the term. A pseudo-interval may be sought from any of the three relations

$$y=o, \frac{dy}{dt}=o, \text{ and } \frac{d^2y}{dt^2}=o.$$

They will give different pitches very close to each other varying through different ranges producing beats which Helmholtz did not reckon. Taking them into consideration we may get better agreement between subjective observations and theoretical results from Helmholtz's theory than we do at present.

21. Singular solutions of ordinary simultaneous differential equations.

C. N. SRINIVASIENGER, Bangalore.

Considering a pair of simultaneous differential equations of the first order in three variables, the possibility of the existence of singular solutions is well-known. Methods of obtaining the singular solutions are also known, when the equations are taken in certain particular *algebraic* forms, wherein the Jacobian of the given functions with respect to the two derivatives involved, can be formed.

It is shown in this paper that the known methods are not at all exhaustive. The present paper gives more exhaustive methods, and generalises the results so as to be applicable to equations involving *transcendental* or *irrational* expressions.

The results obtained in this paper will be found to be of fundamental importance in connection with the discovery of the *Special Integrals* of partial differential equations of the first order.

22. The special integrals of linear partial differential equations of the first order.

C. N. SRINIVASIENGAR, Bangalore.

Fairly exhaustive methods of discovering these special integrals have been given by Prof. M. J. M. Hill in a paper published in the "Proceedings of the London Mathematical Society" Series 2, vol. 16. But while Hill's methods are theoretically exhaustive, in concrete examples they do not generally turn out easy to apply. The present paper gives new methods of obtaining the special integrals, and claims that these methods are simpler than those given by Prof. Hill.

In connection with the geometrical interpretation of the special integrals, I have found it necessary to refer to some wrong statements that are usually made with regard to the *focal surface of a congruence of curves.* The following theorem gives the geometrical significance of the special integral.

The "true special Integral" (of the first class, in Hill's phraseology) of the linear partial differential equation of the first order in three variables, represents either the focal surface or the envelope of a certain single infinity of curves of the congruence defined by the subsidiary equations of Lagrange.

23. Phototropic compounds of mercury.

BH. S. V. RAGHAVA RAO.

The sensitivity of the phototropic compound HS Hg. CNS. has been found to alter on immersion for a short time in a dilute solution of eosin erythrosin, methylene blue, methyl green or malachite green. In the case of eosin and erythrosin second maxima of excitation have been found between 534–569 and 545–620 $\mu\mu$ respectively nearly as intense as

the one in the blue green (462—527 $\mu\mu$) which is characteristic of the pure substance.

The times of darkening and of clearing between standard tints have been measured for the substances HS. Hg. CNS. and I. Hg. CNS. at temperatures of 40, 50 and 60°.

From the results it is deduced that the temperature coefficient of the rate of darkening is 1·0, and that of the reverse reaction is about 1·8 for 10°.

24. The state of polarisation of light scattered by colloidal solutions. Arsenic and antimony sulphides and copper.

A. S. Menon.

An apparatus has been devised to measure the intensity and polarisation of light scattered by colloidal solutions at different angles to the incident beam. The amount of depolarisation of the light scattered by colloidal solutions of arsenictrisulphide, antimonytrisulphide and metallic copper has been investigated at various angles.

The percentage of unpolarised light increases on either side of 90°, the minimum being in all cases at 90°. Addition of electrolytes such as $BaCl_2$ in traces enhances the depolarisation effect. The results obtained show that colloidal particles of copper are spherical, while those of As_2S_3 and Sb_2S_3 are not.

25. A theory of the optical and electrical properties of liquids.

C. V. Raman *and* K. S. Krishnan, Calcutta.

A review of the experimental evidence shows that the existing theories of the refractivity and dielectric behaviour of liquids are inadequate to explain all that is known concerning the changes of these properties with density and temperature. A new theory is accordingly developed in this paper which is based on the idea that the molecules of the fluid are optically and electrically anisotropic, and that, in addition, the polarisation field acting on a molecule in a dense field varies with its orientation relatively to the external field. The theory offers an immediate explanation why in general an increased density causes a diminished molecular refractivity as calculated from the Lorentz formula. It is shown that these changes in refractivity and dielectric constant are closely related to a change in the effective optical or electrical anisotropy of the molecules produced by the influence of its immediate neighbours.

26. The refractivity of liquids.

K. S. Krishnan.

This paper discusses the data for the refractive indices of liquids and their variations with temperature and pressure in the light of the theory referred to in the preceding abstract. The question is considered whether the refractive index of liquids is or is not a function of density only. The attempt is also made to correlate the variations of refraction with the changes in the molecular arrangement within the liquid as indicated by observations on light-scattering at different temperatures.

27. X-Ray diffraction in liquids.

C. M. Sogani.

In two papers recently published in the Indian Journal of Physics,

the author has presented the diffraction data for some 35 liquids and attempted to explain them on general considerations regarding the molecular constitution of liquids. In the present paper the position of the subject is summarised and some further work, theoretical and experimental, dealing with the same topic is presented. In particular, the explanation of the double halo exhibited by carbon tetrachloride is considered in detail.

28. X-Ray diffraction in amorphous solids.

S. S. Ramasubrahmanyan, Calcutta.

The author has studied the modifications of the X-Ray halo due to a glassy solid produced by a rise of temperature and consequent softening and melting. The influence of temperature on the X-Ray halo of liquids has also been studied and is reported on in the paper. The explanation of the results is discussed in relation to the theory of Raman and Ramanathan and the recent work of Sogani.

29. The optical anisotropy of molecules.

I. Ramakrishna Rao.

In a paper published in the current issue of the Indian Journal of Physics, the author has described his studies of light-scattering in some 73 gases and vapours; and attempted to give a general explanation of the many interesting features revealed by an examination of the data. In the present paper, an attempt is made to discuss the relation between the optical anisotropy of the molecule as determined from light-scattering and its chemical structure somewhat more fully. The optical anisotropy of the individual atoms as well as the anisotropy resulting from their juxtaposition and mutual influence are taken into account and discussed.

30. The electric polarity of molecules.

S. C. Sirkar.

The author has studied the dielectric constant of some organic vapours at different temperatures. A comparison is made between the dipole moment as determined from the temperature variation of dielectric constant and as found by the optical method of Raman and Krishnan.

31. Compressibilities of aqueous solutions of fatty acids.

S. Venkateswaran.

The isothermal compressibilities of liquids have been studied by various investigators by the direct method. The discrepancies in the values obtained by different workers, especially at low pressures, is due to the difficulty of completely eliminating the heat of compression, which though small causes a change in volume comparable with the volume changes produced by compression. This source of error can be avoided by determining the adiabatic compressibilities directly and calculating the isothermal values with the help of the thermodynamic equation connecting them. Following Tyrer's method the adiabatic compressibilities of aqueous solutions of formic, acetic, propionic and butyric acids have been determined and the isothermal values calculated from the above expression.

32. Evaluation of special persymmetrics—Part IV.

M. BHIMASENA RAO *and* M. VENKATARAMA IYER.

(Parts 1 and 2 of this paper were read before the fifth conference of the Indian Mathematical Society held at Bangalore in April, 1926, and Part 3 was read before the 14th annual meeting of the Indian Science Conference held at Lahore in January, 1927.)

In this part, the four main results of the first two parts are further reduced to simpler forms. In the persymmetric determinant the values of m are taken in two ranges, one for $m=k\ (2n+1)+m'$, $m'<n$ and $n-m'=p$. The value of the persymmetric is then reduced to the product of two determinants, one of which is a multiple of the determinant whose elements are powers of 2 cos r for values of r from 1 to n and the other involves binomial coefficients. This second determinant, on applying the method of finite differences lends itself to neat simplification with the aid of the results given in the paper on "Two functional determinants with applications" published in the Journal of the Indian Mathematical Society, Vol. XVI.

33. A method for the integration of Pseudo-Elliptic Integrals.

M. BHIMASENA RAO *and* M. VENKATARAMA IYER.

The integration of Pseudo-Elliptic Integrals has been treated by Halphen and others, with the aid of Elliptic Functions. The integration is effected in this paper by an application of the elementary theory of recurring continued fractions, without the aid of Elliptic Functions.

34. Electrical conductivities of mercury amalgams of Potassium and Sodium.

G. R. PARANJPE *and* BUHARIWALA.

These determinations are carried out with a view to confirm the discontinuities in the physical properties of amalgams, existing at definite concentrations. The results obtained so far indicate that in the electrical conductivity curves the discontinuities do exist at the same places as those measured by Bhave in the Viscosity curve. This also corroborates the discontinuities measured by Bhatnagar and others as regards other physical properties.

35. Studies in metallic reflexion.

G. R. PARANJPE.

This is a continuation of the work already reported last year and measurements are now extended to mercury.

36. Sub-soil water movement.

N. K. BOSE.

This problem has been tackled mathematically by only a few people up till now. There are some laws connecting the water profile and the characteristics of the soil, found experimentally by Darcy and others; but they are most approximate and moreover empirical. Realising the importance of his problem in investigating the causes of waterlogging and in finding out means for minimising its effect, the author took it up, as soon as he joined the Irrigation Research Laboratory. Up till now, he has been able to solve a few cases of which the most important is the rate of rise of sub-soil water level. Mathematically, the problem starts with the assumption that all the motion in the liquid is very small

so that we can neglect the inertia terms in Stoke's equation of motion for viscous fluids. Having found the complete solution, velocities at any point in the fluid are so determined that they both vanish at a great depth. The physical condition that is imposed to determine the profile varies according to different problem. Two problems have been worked out completely (1) Effect of rainfall on the sub-soil water profile (2) Effect of combining irrigation with it. The results have been compared with actual experimental data and found to be very satisfactory.

37. Extension of Prandtl's "Tragflügeltheorie."

N. K. Bose.

In this the author has tried to extend his recent work published in the "Zeitschrift für angewandte Mathematik und Mechanick," February 1927. He has calculated the effect of spreading the line-vertex or the lifting line on the plane of the wing of an aeroplane. As a matter of fact, he has calculated the effect of replacing the lifting line by a lifting-plane. This has reduced the difference that was still observable between calculated and experimental data, to a negligible quantity.

38. The thermal structure of the free atmosphere over North-West India.

K. R. Ramanathan.

The paper contains a general account of the changes of temperature and humidity with height up to 20 km. obtained from the records of meteorographs sent up with sounding balloons during the last two years from Agra. The mean height-temperature curves for the cold, hot and monsoon seasons are given and their general features described. Winter conditions over Agra are compared with summer and winter conditions over Europe and monsoon conditions over Agra with conditions over Batavia.

The lowest temperatures of the tropopause and the sharpest inversions in the stratosphere are found to occur at times when the moisture-content of the upper half of the troposphere is high.

An explanation for the increasing temperatures in the stratosphere is sought for in the increasing proportion of ozone as we go up.

39. On the flexure of a partly loaded thin circular plate.

N. M. Basu.

In this paper the deflexion of the middle surface of a thin elastic circular plate has been calculated, on the basis of the 'approximate theory' of Kirchhoff for the following cases.

A. *Clamped edge* ($r=a$).

(1) Load uniformly distributed on the part internal to $r=b$, $b < a$.

(2) Load uniformly distributed on the part external to $r=b$, $b<a$.

(3) Load uniformly distributed on the part $c \leq r < b$, $b \angle a$.

B. *Supported edge* ($r=a$).

Three cases as above.

It has been shown that the method can be easily extended to the case when the load is distributed on any number of concentric circular rings (and the edge is either clamped or supported) either uniformly or according to some function of the distance from the centre. The problem can also be solved when the plate instead of being complete is bounded internally by a concentric circle.

40. On the equilibrium of a thick elastic plate one of whose faces is subjected to a given distribution of pressure and the application of the above to the case of a circular plate.

H. M. Sen Gupta, Dacca.

The problem of the determination of stress and strain in a thick elastic plate one of whose faces is subjected to a given distribution of pressure has been solved for two cases only, viz., when the pressure is uniform or when it varies uniformly with one of the co-ordinates. The present paper consists of two parts. In the first part the general solutions of the displacements and stress components have been obtained when one of the faces of the plate is subjected to a pressure which varies according to the law $p=p_0xy$, where p_0 is a constant. It is found that the formulæ for the stress-couples calculated from these results do not exactly agree with the corresponding formulæ of the approximate theory of Kirchhoff, but that the latter formulæ are approximately correct for the assumed distribution of pressure when the thickness of the plate is sufficiently small. Thus the approximate theory is further confirmed by the results of this part.

In the second part the results obtained in the first part have been utilised to determine the exact solutions of the displacement and stress at any point in a circular plate with clamped edge and subjected to the assumed kind of pressure-distribution.

41. On the gravitational field of an Ideal Gas.

J. Ghosh.

The gravitational equations of Einstein for fields occupied by matter have been solved only in a few cases relating to fluids at rest. For such a medium, assumed to be radially symmetric, all the oblique components of the material-energy-tensor T_p^q vanish, while three of the remaining components which are identified with the pressures of the fluid are equal.

There seems to exist a certain amount of difference of opinion as regards the interpretation of the fourth surviving component $T^4{}_4$, and the assumption of the equation of state. Following the procedure adopted by Schrödinger, Silberstein, Bauer and Eddington, we have assumed the material-energy-tensor for a perfect fluid to be given by

$$T_\mu^{\ \nu} = -\delta_\mu^{\ \nu} p + g_{\mu\sigma}\frac{dx\nu}{ds}\frac{dx\sigma}{ds}P$$

where p and ρ are scalars representing the pressure and density of the fluid at any point. We then *define* a perfect fluid of *ideal* compressibility by the equation $p=\rho$.

The gravitational field of such an ideal fluid has been found in the case when the gravitational equations are of the original form and also when they contain the cosmological constant β. The curvature of the spaces and the differential equations of the light-paths have been determined. The solutions reduce to the galilean and the De Sitter forms respectively when the energy-tensor vanishes.

It is proved that the form of solution which Schwarzschild interprets as belonging to the field of an incompressible liquid sphere placed in a flat space really represents the field of an ideal gas placed in the naturally curved world.

If a fluid sphere under external pressure p is placed in the galilean field, the consequent curvature sets a limit to the radius a of the sphere,

the limit being $(2\pi p)^{-\frac{1}{2}}$. The corresponding limit in the case of the naturally curved world is given by

$$a^2 = \frac{3}{\beta}\left\{ 1-\left(1 \;-\frac{\beta}{12\pi p}\right)^2 \right\},$$

which reduces to $(2\pi p)^{-1}$ if β is neglected, and thus agrees with the former case.

When the fluid fills all space, the pressure, in the first case, diminishes from the given value at the origin to zero at infinity, independently of the initial value. In the second case, the limiting value reached at

$$r= \left(\frac{3}{\beta}\right)^{\frac{1}{2}},$$

is found to be, $\beta/12\pi$, which depends on the natural curvature of space, and is also independent of the pressure at the origin.

42. Rigid bodies in the naturally curved world.

J. GHOSH.

In the theory of relativity, space is regarded as a generalized Riemann surface with a quadratic differential form of four variables. The conception of a rigid body and its motion in such a space is also modified accordingly.

According to Mach's principle, there cannot be a metric of empty space-time. But Einstein's gravitational equations contradict this principle and the empty space is either galilean or De Sitterian according as the equation does not or does contain the cosmological constant.

The metric of the naturally curved world of De Sitter is

$$-ds^2=e^{-\tau}dr^2+r^2d\theta^2+r^2\sin^2 d\theta^2-e^{\tau}\, dt^2$$

where $\tau=log\,(1-\frac{1}{3}ar^2)$, which is an S_4 with constant Riemann-curvature $\frac{3}{a}$.

The motion of rigid bodies in non-euclidean elliptic space has been discussed by Ball, Buchheim and others. The motion of rigid bodies in the 4-dimensional galilean space has been investigated by Born, Noether, and Herglotz. The object of the present paper is to extend the ideas of Born and Herglotz to the case of rigid bodies in the De Sitter's empty world.

The differential equations of the conditions of the existence and motion of rigid bodies have been found for such a space and these reduce to the conditions obtained by Herglotz when the space-time is galilean. In particular, conditions are deduced for the particles of the body describing system of lines parallel to the direction of the time-axis, in which case the body may be regarded as stationary with respect to the spatial co-ordinates.

43. Critical electron energies and spectra of hydrogen molecule.

SUSIL CHANDRA BISWAS, Dacca.

Studies of the Ultra-violet emission and absorption bands lead to a conclusion that the Witmer (Lyman) and Werner bands have different initial electronic states but a common final state and that this final state is the normal state of the molecule. The energy differences corresponding to these two transitions—(Dieke and Hopfield—z.f. Physik, 1926) are found to be 11·3 and 12·3 volts (experimentally 11·5 and 12·6 volts respectively). There is evidence that at about 12·6 volts, excitation of the

Hydrogen molecule is attended with dissociation. This indicates that the effective dissociation voltage for this stage will be about 2·4 volts, which is also significant in being the region of maximum intensity in the long wave-length limit of a continuous blue spectrum which makes its first appearance at about 12·6 volts (Horton, 1923).

Dissociation process and products of dissociation in Hydrogen molecule are discussed. Electron affinity of Hydrogen seems to be about 1·9 volts.

Possibility of formation of a meta-stable Hydrogen molecule in the electron path at about 12·6 volts is also discussed.

44. Ionisation potential of Niton.

SUSIL CHANDRA BISWAS, Dacca.

Curves showing the relation between ionisation potentials and atomic numbers were found to represent elements having the same energy level in the same group. They were also shown to obey Stoner's sub-level scheme completely for L and M shells and for other shells the same was found true for elements near the completion of the configuration of the shell. For first five shells with increase in the order number there is a gradual decrease in the ionisation values, whether this generalisation can be extended to the sixth or P—shell is not certain. On the other hand, ionisation values of Au, Hg, Tl, Pb, indicate that ionisation values for these elements instead of falling off rather increase appreciably.

It may be probable that this abnormality in elements of P—shell may be a characteristic property of this shell. This seems to be warranted also by a study of the 'space lattice' distances of the elements in the solid state. On this basis then, an ionisation value greater than that of Xenon may be assigned to Niton which seems to be probable at about 15 volts. Turner (1924) ionisation potential of Niton $27{\cdot}5 \pm 1{\cdot}5$ volts. Glockler (1925), Struwe (1926) ionisation potential of Niton (8—10) volts.

45. Characteristic frequencies of atoms.

SUSIL CHANDRA BISWAS, Dacca.

46. A method of examination of transient glows and their spectra.

H. PARAMESWARAN, Madras.

This is a method suitable for the visual observation, photographic and spectroscopic studies of transient glows observed in some rarefied gases under chemical excitation during and after discharge. The device used consists of a mercury break carrying on its extended spindle a disc with an adjustable aperture in it. The glow is observed through this aperture. The break being mounted on a base that can be rotated by a slow motion arrangement, it permits of the lag being adjusted to a nicety under practical running conditions.

47. The action of abrasives in optical grinding.

H. PARAMESWARAN, Madras.

The paper discusses a theory of action of the modern sharp abrasives like carborundum and crushed steel. Explanation for some of the unsymmetrical effects observed is sought in terms of the unsymmetrical cut which such sharp abrasives seem to make. Experimental evidence from examples of practical grinding in support of this view is quoted.

48. Absorption of X-Rays by colloidal solutions.

KAILASH NATH MATHUR *and* HARI RAM SARNA.

The mass absorption coefficient of silver in the form of a colloidal solution has been examined for an effective wave-length of λ·6 using the filtered X-rays from a Coolidge Tube. The value of $\frac{\mu}{\rho}$ obtained is found to be much larger than the value for silver in the usual form.

49. On the solution of kinematical problems by the method of Vectors.

PROF. K. KHASTAGIR.

In this paper two well-known problems for determining components of velocities and accelerations in polar and cylindrical co-ordinates have been solved.

50. A geometrical investigation.

A. A. KRISHNASWAMI IYENGAR.

In this paper, the author investigates the properties of quadrilateral and conic chains generated as follows :—

Two consecutive quadrilaterals of the chain are so related that the vertices of one of them are the circumcentres of the triangles formed by the vertices of the other taken in triplets.

The conics of the chain circumscribe these quadrilaterals and pass through the centres of the rectangular hyperbolæ through the vertices.

It is shown that (1) the alternate members of the chain are homothetic and converge to a limiting point; (2) the point of convergence is the Fregier point with respect to the conic chain at the centres of the rectangular hyperbolæ circumscribing the members of the quadrilateral chain; (3) any side of a member of the quadrilateral chain subtends at the limiting point an angle equal to the sum of the angles subtended at the extremities of the opposite side; (4) the circles of similitude of the circles taken in pairs through the triplets of vertices of any member of the quadrilateral chain pass through the limiting point.

Numerous interesting metrical results relating to the structure of the chains are also noticed in the paper.

51. A note on Bhaskara's simultaneous indeterminate equations.

A. A. KRISHNASWAMI IYENGAR.

In an article published in the Bulletin of the Calcutta Mathematical Society (Vol. 16, Nos. 2 and 3, 1926) Professor Saradkanta Ganguli attributes to Bhaskara certain rules relating to the solution of simultaneous linear indeterminate equations. This paper re-examines all the available evidences, internal and external, for the genuineness of the authorship of these rules and attempts to show that they cannot be in the fitness of things Bhaskara's but must be spurious interpolations of some Andhra commentators. It is also pointed out that there exist better Indian methods which are more scientific and in a line with the work of Aryabhatta, Brahmagupta, and Mahavira in simultaneous indeterminate equations.

52. Series in the first spark spectrum of Tin (Sn. II).

A. L. NARAYAN *and* K. R. RAO.

The spark lines of Tin have been classified into the several stages of

ionisation Sn. II, Sn. III, Sn. IV by studying the spectrum under varying conditions of excitation and the lines have been measured finally in the 2nd. order of a 5 ft. concave grating.

According to the theory of spectra recently developed the first spark spectrum arises from transitions of one electron successively through the O_2, P_1, O_3, P_2, Q_1, O_4, etc., shells which result in the usual doublet terms. These are found to be

$1^2P_1=117678{\cdot}8$	$1^2D_3=45639{\cdot}8$	$2^2D_3=27302{\cdot}7$
$1^2P_2=113431{\cdot}8$	$1^2D_2=46287{\cdot}2$	$2^2D_2=27414{\cdot}8$
$2^2P_1=46160$	$1^2S=60766{\cdot}8$	$3^2D_3=17301$
$2^2P_2=45273{\cdot}9$	$1^2F=28401{\cdot}3$	$3^2D_2=17361{\cdot}1$
		$2^2F=[18040]$

The configuration of one O_1 and two O_2 electrons gives $^4\overline{P}$, a^2D, $^2\overline{P}$, a^2 terms. Of these the a^2D term equal to 58847·5 is found to form combinations with the regular 1^2P term and a strong series with ^2F terms.

The largest term is 1^2P_1 giving the second ionisation potential of Tin as 14·5 volts.

As a result of the analysis about 30 lines of the first spark spectrum have been classified which include a large number of the prominent lines in the quartz and fluorite region.

53. Doublets in As. III, Sb. III and Bi. III.

K. R. RAO *and* A. L. NARAYAN.

Investigation of the spark spectrum of As. under different experimental conditions showed the existence of three prominent pairs with $\Delta\nu=$ in the ordinary range of observation, which are found to belong to doubly-ionised Arsenic and the following assignment is in accord with theory.

	λ		ν	$\Delta\nu$.
$1S-2P_1$	4037·17	(8)	24763·8	723·2
$1S-2P_2$	3922·61	(10)	25487·0	
$2P_1-2S$	3180·78	(3)	31431·1	723·1
$2P_2-2S$	3255·69	(5)	30708·0	
$2P_2-3D_2$	2989·54	(4)	33441·6	722·4
$2P_1-3D_2$	2926·32	(10)	34164·0	84·5.
$2P_2-3D_3$	2982·00	(10)	33526·1	

Corresponding doublets in Sb. III and Bi. III are respectively,

		λ		ν	$\Delta\nu$.
Sb. III.	$1S-2P_1$	4591·89	(5)	21771·5	1668·1
	$1S-2P_2$	4265·09	(6)	23439·6	
	$2P_1-2S$	4352·25	(6)	22970·2	1668·2
	$2P_2-2S$	4693·09	(5)	21302·0	
Bi. III.	$1S-2P_1$	4561·15	(50)	21924·5	5135·3
	$1S-2P_2$	3695·52	(50)	27059·8	
	$2P_1-2S$	3541·36		28237·74	5136·2
	$2P_2-2S$	4328·71		23101·57	

Details of these doublet systems will be published shortly.

54. $^3P\overline{P}$ Groups in singly-ionised Antimony and Arsenic.

K. R. RAO *and* A. L. NARAYAN.

The theoretical considerations put forward by Heisenberg and Hund indicate that the most easily excited wave-lengths in the spectra of the singly-ionised elements of Group V of the periodic table should form a $^3P\overline{P}$ Group. The following are the probable multiplets of this type dis-

covered in Sb. II and As. II. In the case of Sb. the group is confirmed by the other combination $^3\bar{P}\ \bar{S}$.

Sb. II.

	$1^3\bar{P}_2$	4569·0	$1^3\bar{P}_1$	723·0	$1^3\bar{P}_0$
2^3P_0			6130·03 (10) 16308·63		
2^3P_1	7136·29 14009·04		5381·04 (8) 18578·61		5179·36 (8) 19302·05
2^3P_2	6005·07 (10) 16648·0		4711·96 (8) 21216·67		
$1^3\bar{S}_1$	6079·68 16443·69		4757·91 (6) 21011·77		4599·68 (4) 21734·58
a_1			3850·21 (7) 25965·28		4219·09 23695·15.

As. II.

	$1^3\bar{P}_2$	1585·8	$1^3\bar{P}_1$	$1^3\bar{P}_0$
2^3P_0 494·1			5651·56 (10) 17690·0	
2^3P_1 1389	6023 (8) 16598·9		5498·01 (10) 18184·1	? 5331·47 (9 18751·6
2^3P_2	5558·34 (10) 17986·7		5107·82 (8) 19573·1	

Further investigation on these spectra is in progress.

55. On the fine structure of the lines of Thallium in the Ultra-Violet.

WALI MOHAMMAD.

Realizing the importance of an accurate knowledge of the fine structure of spectrum lines the authors have undertaken a systematic investigation of the lines of different elements in the Ultra-Violet region. Their first study on the Cadmium was reported last year. The present work is an extension of the same to Thallium.

With the aid of a quartz Lummer-Gehrke plate and an E_3 quartz Hilger Spectrograph and a specially constructed source of light the fine structure of the following lines of Thallium has been determined for the first time

Thallium :— λ3775·89, λ3529·52, λ3519·38, λ3229·89, λ3230·7, λ2921·66, λ2918·42, λ2826·45 and λ2767·87.

Several of these lines have been found to possess satellites while some of them are simple in structure.

56. On a problem in gyrostatics.

HARENDRANATH DATTA, Dacca.

To illustrate the production of elastic quality by motion, Lord Kelvin suggested a gyrostatic arrangement which should have the properties of a spiral spring. One of the ways in which attempts were made to realize this "gyrostatic spring balance" was by making use of gyrostats (all exactly similar) in which the fly-sheels are rotors of electricity driven motors, and driving all with the same current. A complete solution of this problem requires the integration of the equation

$$(a+\beta\sin^2\theta)\frac{d^2\theta}{dt^2}+\beta\sin\theta\cos\theta\left(\frac{d\theta}{dt}\right)^2-(c_n+a\mu\cos\theta)$$

$$\mu\sin\theta+g(2M+M_1)a\sin\theta=0 \qquad \text{———(i)}$$

It appears to me that the above equation has not been discussed except when the vibrations about steady motion are small in which case the term in $\left(\frac{d\theta}{dt}\right)^2$ can be neglected.

The object of this note is to point out that the above equation can, in the most general case, be solved in terms of a *finite* number of *hyperelliptic* integrals.

57. On a certain equation in mathematical physics.

HARENDRA NATH DATTA, Dacca.

In course of a systematic treatment of the two dimensional motion of a particle in the field due to a doublet, Dr. Dorothy Wrinch has shown that the determination of the orbits, in certain cases, can be made to depend on the integration of the equation.

$$2(\cos w-\cos k)d^2u/dw^2-\sin w\ .\ du/dw-2u\ .\ \cos k=0\ldots(\text{i})$$

Ultimately however, Dr. Dorothy Wrinch proceeded in a different manner, and obtained the equations of the orbits in terms of S_n (the Jacobian Elliptic function) and other elementary functions of a *parameter*.

In this paper, the author has (I) obtained a solution of the above equation in a single relation containing elliptic integrals, (II) transformed the equation into one with *rational* coefficients, and studied the nature of the algebraic solutions of the latter, and (III) investigated the position of the transformed equation among the equations of mathematical physics.

58. On the Rotating Electron.

M. N. SAHA, Allahabad.

Einstein and Ehrenfest, in a paper published (*Zs. f.* Physik, Vol. 9,) raised an objection against the explanation of Stern and Gerlach's famous experiments on the directional quantisation of atomic streams. Stern and Gerlach proceeded from the idea that every atom is a magnetic doublet, the magnetism arising from the orbital motion of the constituent electrons; the magnetic moment can be easily calculated from spectroscopic data. They projected streams of atoms into a nonhomogeneous magnetic field and found that the stream is deflected into a number of well defined beams.

Einstein and Ehrenfest pointed out that the axis of the stream of atoms, before they enter the field, must be distributed in space at random, and when they enter the magnetic field, the axis will describe a precessional motion round the axis. This motion must be damped, before the axis can set itself parallel to the field. The time for orientation according to Einstein and Ehrenfest, is 10^{15} sec., while the actual time is 10^{-5} sec.

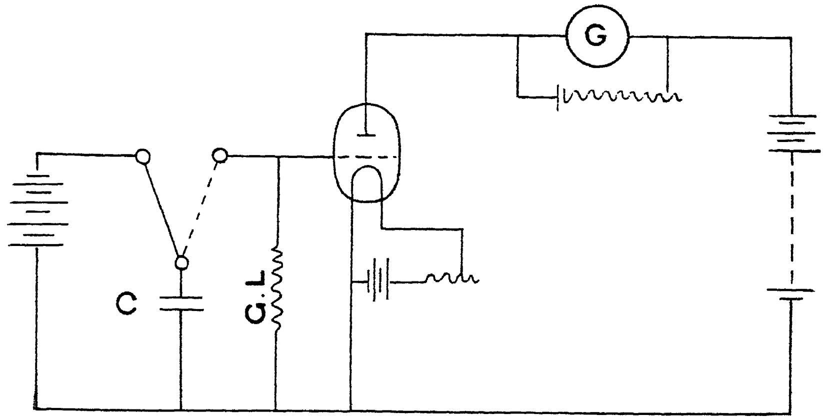
So far this objection has not been met, and in the opinion of the author, it is inexplicable on the conception of the orbital motion of the electrons. If however we suppose that the magnetism arises from the rotation of the electron (as is conceived in modern theories of complicated spectra) the difficulty disappears. In the case of a stream of atomic, *H*, *Na*, or *K*, the magnetism of the atom is due to the rotation of the valency electron, the atomic rumpf being magnetically neutral. Hence the rotating electron is subjected to the magnetic field, and will execute a precessional as well as a nutational motion about the external magnetic axis. It can be shown, with reasonable assumptions about the moment of Intertia of the rotating electron that the difficulty raised by Einstein and Ehrenfest disappears entirely.

The explanation is quite in agreement with Schrödinger's explanation of the H-spectrum.

59. Measurement of capacity and high resistance by means of a thermionic valve.

G. R. Toshniwal.

Making use of the following arrangement it has been found possible to measure capacitites as low as 5 cms. with in 1% of accuracy.



The relation between the capacity and the deflection in the galvanometer has been found to be a straight line except in the case of very small capacities when the capacity of the connecting wires, etc., are also considerable.

Keeping capacity constant and varying the grid leak a straight line relation has again been found between the deflection and the resistance.

60. Regularities in the spectrum of ionised neon.

P. K. Kichlu, Allahabad.

The paper gives details of the analysis of the spectrum of singly ionised neon, which has been done by the author during the course o f the past year. Adopting the Stoner-scheme of the arrangement of elec - trons in an atom of $Ne+$, a comparison is drawn in the following tabl e between the terms calculated on the basis of Hund's theory of complica t-ed spectra and the terms actually observed.

Position of Valence electrons.	Terms (Calculated.)	Terms (Observed.)
$5L_2$	$2P$	
$4L_2M_1$	$^4\bar{P}\,^2D\,^2S\,^2\bar{P}$	$^4\bar{P}\,^2\bar{P}$
$4L_2M_2$	$^4\bar{D}\,^4P\,^4\bar{S}\,^2\bar{D}\,^2P\,^2\bar{S}$	$^4\bar{D}\,^4P\,^4\bar{S}\,^2\bar{D}\,^2P\,^2S$
$4L_2M_3$	$^4\bar{F}\,^4D\,^4\bar{P}\,^2\bar{F}\,^2D\,^2\bar{P}$	$^4\bar{F}\ D\,^4\bar{P}\,^2D\,^2P$
$4L_2N_1$	$^4\bar{P}\,^2D\,^2S\,^2\bar{P}$	

61. A note on the spectrum of ionised krypton.

P. K. Kichlu, Allahabad.

The author has made a preliminary study of the lines of spectrum of $Kr+$ and observed three groups of terms A, B, and C, such that A combines with B, and B with C, and account for a large percentage of lines. The terms are given below. The values assigned are purely arbitrary, the deepest level so far discovered corresponding to 0.

A.

0	2263·6	4774·4	5645 7

B.

21094·9	21457·7	22952·1	27306·1
25550·4	26272·7	27288·0	27306 1
28891·5	29164·5	29532·4	

C.

44247	45053·8	48577·4	48620·0
48970·1	48045·7	49227·2	48734·2
50526·3	51607·5	52245·5	52310·1

62. Regularities in the spectrum of ionised silver.

K. Majumdar, Allahabad.

Spark spectrum of silver has been investigated theoretically from the standpoint of the theory of complicated spectra. Several constant frequency differences have been obtained and the fundamental triplet d-terms corresponding to the outer shell structure $d^9\ s^1$ ($9\ N_3O_1$) have been identified. The lowest fundamental term corresponding to the structure d^{10} ($10\ N_3$) has not yet been obtained. Probably the terms are far down in the ultra violet, and investigations must be carried out with vacuum spectrograph.

63. On the temperature radiation of Thallium vapour.

K. Majumdar *and* P. K. Kichlu, Allahabad.

Emission spectrum of hot Thallium gas contained in a vacuum furnace with temperature varying from 1500° to 2300°C. was investigated with the aid of a small quartz spectrograph. No emission line was obtained at 1500°C. Emission begins at 1800°C.

At 1900°C the $2p_2-3s$ line (5350) was obtained in emission while $2p_1-3s$, (3775) was obtained in absorption. Even at 2300°C, the line 3775 could not be obtained in emission.

The result is discussed from the standpoint of theory of temperature radiation and quantum theory of spectral emission.

64. Notes on the gravitational field with axial symmetry.

N. R. Sen *and* N. N. Ghosh, Calcutta.

Starting with Weyl's line-element in a field with axial symmetry

$$ds^2 = f\,dx_1^2 - h(dx_4^2 + dx_2^2) - l\,dx_3^2$$

it can be shown that l may be replaced by r^2/f where r, in the case when the "meridian planes" are subject to equal pressure and tension in radial and axial directions in the plane, satisfies the equation $\Delta r = 0$. Under these conditions a system of canonical co-ordinates can be obtained. The following two conclusions can be drawn under slightly more general conditions.

1. There cannot be any system in statical equilibrium in which the "stresses" in a meridian "plane" all vanish. But there is only one

exception, viz., when the field has the symmetry of a circular cylinder (G-field depending entirely on one co-ordinate, e.g., the distance from the axis).

2. If in addition also the "stress" in the azimuthal direction vanishes the space is entirely free from matter. Hence a swarm of incoherent material particles of *any* density whatsoever cannot rest in statical equilibrium round an axis of symmetry. Other generalisations of some of the already existing results are also possible.

65. On a comparison of de Broglie wave with luminous vibration.

N. R. SEN, Calcutta.

The identification of the amplitude of a de Broglie wave (the same as Schrodinger's vibrating scalar) of a light quant of mass $m_0=\epsilon_0/c^2$ moving with velocity $v(v\angle c)$ with the ordinary luminous vibration of frequency ν leads to the relation

$$h\nu=\sqrt{E^2-m_0^2c^4}=\sqrt{E^2-E_o^2},$$

where E is the total energy of the quant. Whereas in an atomic system the emission frequency is proportional to the difference of the energies of the system in its two states the square of the frequency of light vibration is derived in a similar way from the difference of the squares of the total energy and intrinsic energy of the light quant. E_o being small compared to E, the frequency of the light quant arises almost entirely out of its kinetic energy. Again, the velocity of the quant, except for very low frequencies, calculates out to the value

$$v=c\left(1-\frac{m_0^2c^4}{2h^2\nu^2}\right).$$

Exactly this velocity of the light quant explains the phenomena of Doppler effect in frequency and intensity and reflection in moving mirror, as has been shown by de Broglie.

66. On the solution of the equations of elastic equilibrium suitable for elliptic boundaries.

S. GHOSE, Calcutta.

In the case of plane strain the stress components are expressible as second differential coefficients of a stress function satisfying the equation $\nabla^4\chi=0$. A set of solutions of the equation can be constructed in the form of series, which can be applied to cylinders with elliptic sections or elliptic hollows, etc. As an application the state of strain in an elliptic cylinder which has suffered dislocation due to a triangular axial fissure has been worked out.

67. An improved method of computing the probable error of a coefficient of correlative as found from a fourfold table.

M. VAIDYANATHAN, Madras.

On the assumption that the frequency distribution is normal, we can by aid of Evereth's tables of tetrachoric functions rapidly find r, the correlation coefficient of a fourfold table. On the same assumption K. Pearson has found (Phil. Trans. 1900) the probable error of r which is indeed very laborious in use. This paper is an attempt to evolve a simple formula which is the combined product of the two cases (a) of the fourfold

division at the mean (b) of the case where $r=o$. The probable error or r thus deduced gives strikingly accurate results when compared with the laborious formula. Illustrations are added to exemplify the formula. The formula deduced is :—

Probable error of $r=$

$$\frac{2}{3\sqrt{n}} \cdot \overline{\frac{1-r^2}{H-K}} \sqrt{\left\{1-\left(\frac{Sin^{-1} r}{90^0}\right)^2\right\}\frac{1}{4}\left(1-a_1^2\right)\times\frac{1}{4}\left(1-a_2^2\right)}$$

68. Stages in the excitation of the spectrum of Arsenic.

P. Pattabhi Ramiah *and* K. R. Rao.

A highly condensed discharge was passed through electrodes of pure Arsenic enclosed in a globe which can be either exhausted or filled with any gas at the desired pressure and the emission spectrum was studied under different conditions.

In order to classify the lines and assign them to the various stages of ionisation of the Arsenic atom—As. II, As. III, As. IV—photographs were taken by varying the intensity of discharge, which was attained by adjusting the pressure of the residual gas or by changing the self-induction and capacity in the circuit.

Accurate measurements of these lines and the analysis of the spark spectra of Arsenic are in progress.

69. On a new method of comparing viscosities of liquids by oscillating columns.

G. Subrahmaniam.

It is shown that in the case of a liquid contained in a v-tube and making *small and steady* oscillations the rate of decay of such oscillations is related to the coefficient of viscosity by the expression :—

$$\nu=\frac{b^2\lambda}{2\tau};$$

where 'ν' is the kinematic coefficient, 'λ' the logarithmic decrement, 'τ' the free period and 'b' a constant which is assumed to be the same for the same tube and different *wetting* liquids. As the period of oscillations 'τ' depends only on the total length of the liquid column and the inclination of the arms of the bent tube to the horizontal the above expression leads to a new method of comparing viscosities by noticing the log. decrements of equal lengths of different liquids oscillating in a given tube.

This relation has been verified in the case of five different tubes of 0·3—1·0 cm. diams. and seven liquids, namely, water, alcohol, ether, Xylene, benzene, turpentine and carbon disulphide and the results are in perfect accordance with the theory.

70. The calibration of a thermionic valve-oscillator between 300 and 7,000 cycles per second.

T. S. Rangachari.

A simple volt-meter method used for comparing the frequency of the oscillator with that of a standard valve-maintained tuning fork over a range of 300 to 7,000 cycles per second is described. The higher frequency range for 3,000 to 7,000 cycles per second was calibrated by means of a cathode ray oscillograph and standard radio-frequency wavemeter an intermediate frequency circuit being utilised by means of beats for coupling the oscillator to the wavemeter.

In order that the oscillator may be subjected to a negligible load only an amplifier was connected between its output and the measuring circuits.

71. A self-recording electrometer for cosmic radiation measurements.

J. M. BENADE, Lahore.

A special form of self-recording electrometer was designed and built to record the rate of production of ions due to penetrating radiation at the surface of a high altitude lake and at various depths below the surface in order to determine the absorption coefficient of the radiation. The instrument consists of a large brass ionization chamber on which is mounted a diverging leaf electrometer. Instead of gold leaf phosphor bronze ribbons are used, making the instrument quite rigid and portable. Clockwork rotates a photographic film on which is recorded a magnified image of the tips of the filaments by the lighting of a small lamp at intervals of eight minutes. The recording apparatus is protected by means of a brass cover which carries an eyepiece and scale for direct readings. This cover is sealed to the ionization chamber making the instrument water tight. Using air at atmospheric pressure in the ionization chamber the instrument is sufficiently sensitive to measure one ion per cubic centimeter per second, and has a temperature coefficient of about one half per cent. per degree Centigrade.

72. Radio telephony modulation ratio measurements.

M. N. DORASWAMY.

An extension of the method of measuring modulation of a telephone transmitter at the receiving station, proposed by L. B. Turner was adopted in measuring the modulation ratio of the 320 meter transmitter at the Indian Institute of Science. The receiving station was located at a distance of about 7 miles.

The measuring set consisted of a two stage transformer-coupled high frequency amplifier and a detector in the anode circuit of which are included the measuring milli—and micro-ammeters and also in a parallel circuit with these ammeters was included the audio choke shunted by a Moullin thermionic voltmeter to measure the audio voltage drop. The one important precaution that was to be taken was to ensure that there was no radio-frequency voltage drop across the choke. This was tested with the help of the wave meter. The quantities to be measured are :—

(1) The average value of the audio voltage.

(2) The average value of the radio-frequency voltage.

The first was measured by the thermionic voltmeter. Second was measured by the change in anode current due to the signal.

From the experimental results it was found that the most suitable value of the percentage modulation consistent with good quality of reproduction was between 25 and 50% for music and 40 and 60% for speech for the particular transmission tested.

73. A change in the refractive index of air where an electric glow discharge is passing through it.

J. B. SETH *and* Students.

The change is studied by observing the shift in the interference fringes obtained by Jamin's plates. The change is purely local in the region of the luminous discharge. By varying the pressure of the air inside, it is found that the shift is a maximum at a pressure of the order of 2·5 cms.

Ionisation of air by X-Rays or by Tesla discharge does not cause an appreciable shift.

Whether the change is purely a temperature effect caused by the passage of discharge through the air is being studied. The shift was very small in the preliminary experiments. It has been considerably increased and a higher degree of accuracy is expected.

74. The change of resistance of a carbon pencil line.

J. B. SETH *and* Students.

The resistance of a pencil line is found to behave in a peculiar manner and its value is found to differ under different conditions. An attempt was made to investigate the various causes which affect the change. The humidity of the air produces a marked change in the resistance, increasing with humidity. A small rise of temperature does not cause an appreciable change in the resistance. Further work is being done to find whether the change in the resistance with humidity can be utilised for studying the amount of moisture in an enclosed space.

The resistance is also found to diminish with an increasing voltage as was found in the case of a Selenium cell by Four d' Albe.

75. A note on the relative absorption of the primary and scattered X-rays by Silver and Tin.

S. R. KHASTGIR, Calcutta.

In the experiments of J. A. Gray (Trans. Roy. Soc. Canada, Vol. 16, Sec. 3, 1922) on the relative absorption of the primary and secondary (scattered) X-radiations by silver, the secondary beam was found to be *harder* than the primary, when the average frequency of the latter was slightly greater than the K-characteristic absorption frequency of silver. Gray interpreted this result as due to a real change in the wavelength of the radiation on scattering. The scattered radiation being of a longer wavelength could not excite the K-characteristic radiation in silver, while the primary radiation did, the latter having a wavelength slightly shorter than the wavelength of the AgK-radiation. The object of the present paper is to show that this interpretation of Gray does not express the truth about the phenomena associated with a scattered X-radiation and that the experimental result of Gray, on the other hand, reveals features characteristic of Barkla's J-phenomenon, taking place in the absorbing substance, e.g., in silver in the present case.

The results of a few absorption experiments recorded in this paper, not only show that the theory of wavelength change on scattering is incompatible but that the greater absorbability of the primary radiation, as observed by Gray, is most certainly due to the J-transformation in silver.

76. The absorption of scattered X-rays and Compton's theory of scattering.

S. R. KHASTGIR, Calcutta.

The most significant feature in the comparison of the absorbabilities of the secondary (scattered) and primary X-rays by the method of Barkla and Khastgir (Phil. Mag., Nov., 1925), is the constancy, over a wide range of wavelengths, of the ratio of the ionisations produced by the secondary and primary beams, when the beams are either *unintercepted* or *intercepted* by similar sheets of an absorbing substance. Two alternative cases A and B have been recorded. In case A, discontinuities in the 'intercepted' ratio S'/P' are obtained and in case B, the values for the 'unintercepted' ratio S/P and the 'intercepted' ratio S'/P' for various wave-

lengths are found to lie on two parallel horizontal lines without the slightest sign of any discontinuity. In the present paper, attention is directed only to the case B of these experiments which is the only case giving results, at all capable of explanation in terms of Compton's theory of wavelength change on scattering. An attempt had been made to test Compton's theory, taking into account the heterogeneity of the X-radiation experimented upon.

Calculations of the ratio S′/P′ are based on C. T. Ulrey's energy distribution curves (Phys. Rev., May, 1918) of tungsten for voltages 20, 25, 30, 35, 40 and 50 KV. The area of each curve gives the total energy of radiation emitted at each voltage. Since the 'unintercepted' ratio S/P can be shown to be constant (except for very short waves), the energy distributions for the primary and scattered radiations can be taken to be proportional to each other. From these curves of Ulrey, corresponding curves are then constructed for both primary and scattered beams, when they are intercepted by an equal thickness of an absorbing material. In the case of the scattered beam, the increased value of the absorption coefficient, corresponding to Compton's wavelength change has been used. The presence of an unmodified radiation in the scattered beam has also been taken into account. Thus for six voltages, six pair of distribution curves for the *intercepted* scattered and primary beams are obtained, the ratio of the areas of each pair giving the value of S′/P′ for each voltage.

Aluminium and Gold have been used as absorbers. In both the cases, the computed curves for S′/P′ do not agree with the experimental results of Barkla and Khastgir. Calculations could be similarly made with other substances, e.g., copper, silver and tin.

77. A note on a factorable continuant.

SATISH CHANDRA CHAKRABARTI, Calcutta.

1. If
$$\alpha_r = -\frac{(a^{r+1}-1)(a^r-1)\,a^{2n-2r-1}}{(a^n-1)(a^{n-1}-1)}$$
$$\beta_r = \frac{(a^{r+1}-1)(a^{r-1})(a^2-1)\,a^{2n-2r-2}}{(a^n-1)(a^{n-1}-1)(a-1)}$$
and
$$\gamma_r = \frac{(a^{n-r-1}-1)(a^n+a^{n-1}-a^{n-r-1}-1)}{(a^n-1)(a^{n-1}-1)}$$

then the continuant

$$\begin{vmatrix} x & 1 & & & \\ \alpha_1, & x+\beta_1, & \gamma_1 & & \\ & \alpha_2, & x+\beta_2, & \gamma_2 & \\ \cdots & \cdots & \cdots & \cdots & \cdots \\ & & & \alpha_{n-1}, & x+\beta_{n-1} \end{vmatrix}_n$$
$$=(x+1)(x+a)\left\{x+\frac{(a^{n-2}-1)(a^n+a^{n-1}-a^{n-2}-1)\,a^2}{(a^n-1)(a^{n-1}-1)}\right\}$$
$$\ldots\ldots\ldots n \text{ factors} \ldots (1)$$

the κth factor being
$$x+\frac{(a^{n-k+1}-1)(a^n+a^{n-1}-a^{n-k+1}-1)\,a^{k-1}}{(a^n-1)(a^{n-1}-1)}.$$

This identity has been proved by performing $n-1$ successive operations on the continuant.

2. If $\alpha_r = \frac{(a^r-1)(2a^{n-1}-a^{n-r}-1)}{(a^{n-1}-1)(a-1)a^{r-1}}\alpha_1 + \frac{(a^r-1)(a^{r-1}-1)a^{n-2r+1}}{(a^{n-1}-1)(a-1)}\beta_1$

$$-\frac{(a^r-1)(a^{r-1}-1)a^{2n-2r-1}}{(a^{n-1}-1)(a^{n-2}-1)}\gamma_1,$$

$$\beta_r = -\frac{(a^r-1)(a^{r-1}-1)(a^2-1)a^{n-2r}}{(a^{n-1}-1)(a-1)^2}\alpha_1$$

$$-\frac{(a^r-1)(a^{n-2}-a^{n-r}-a^{n-r-1}+1)}{(a^{n-1}-1)(a-1)a^{r-1}}\beta_1$$

$$+\frac{(a^r-1)(a^{r-1}-1)(a^2-1)a^{2n-2r-2}}{(a^{n-1}-1)(a^{n-2}-1)(a-1)}\gamma_1,$$

and $\gamma_r = -\frac{(a^{r-1}-1)(a^{n-r-1}-1)}{(a^{n-1}-1)(a-1)a^{r-1}}\alpha_1 - \frac{(a^{r-1}-1)(a^{n-r-1}-1)}{(a^{n-1}-1)(a-1)a^{r-1}}\beta_1$

$$+\frac{(a^{n-r-1}-1)(a^{n-1}+a^{n-2}-a^{n-r-1}-1)}{(a^{n-1}-1)(a^{n-2}-1)}\gamma_1,$$

then the continuant

$$\left|\begin{array}{cccccc} x, & \gamma_0 & & & & \\ \alpha_1, & x+\beta_1, & \gamma, & & & \\ & \alpha_2, & x+\beta_2, & \gamma_2 & & \\ \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\ & & & & \alpha_{n-1}, & x+\beta_{n-1} \end{array}\right|_n$$

$$=(x+\alpha_1+\beta_1+\gamma_1)(x-\alpha_1+a\gamma_1)\left\{x-\frac{a^{n+1}+a^n-2a^{n-1}-a^3+1}{(a^{n-1}-1)(a-1)a}\alpha_1\right.$$

$$\left.-\frac{(a^{n-3}-1)a}{a^{n-1}-1}\beta_1+\frac{(a^{n-3}-1)(a^{n-1}+a^{n-2}-a^{n-3}-1)a^2}{(a^{n-1}-1)(a^{n-2}-1)}\gamma_1\right\}$$

$$\ldots\ldots\ldots\ldots\ldots n \text{ factors} \ldots (2)$$

the κth factor being

$$x-\frac{a^{n+k-2}+a^{n+k-3}-2a^{n-1}-a^{2k-3}+1}{(a^{n-1}-1)(a-1)a^{k-2}}\alpha_1-\frac{(a^{n-k}-1)(a^{k-2}-1)a}{(a^{n-1}-1)(a-1)}\beta_1$$

$$+\frac{(a^{n-k}-1)(a^{n-1}+a^{n-2}-a^{n-k}-1)a^{k+1}}{(a^{n-1}-1)(a^{n-2}-1)}\gamma_1.$$

This is the most general continuant which is resolvable by the same operations as (1).

78. On "ghost lines" caused by an adsorbed layer on the grating surface.

SATYENDRA RAY.

The "ghost lines" are supposed to be caused by a periodic irregularity in the grating ruling. To test another theory of the lines the author washed the surface of the grating, while in its situation on the spectrometer table for viewing the "ghost lines," by means of alcohol and petrol respectively. In both cases lines more widely spaced than the ghost lines appeared with the film of the liquid on the grating surface, the distance apart between the lines closing up with evaporation of the film and finally collapsing into the ghost lines as a "limiting position" of sorts.

The "ghost lines" for the green line of Hg lamp were also found with subjective observation to appear violet in colour on seeing obliquely through the eye piece.

79. On the spectra of Beryllium.

S. N. Bose *and* S. K. Mukherjee.

Both the arc and the spark spectra of Beryllium (nitrate and metal) are being investigated with Hilger's E Spectrograph. The preliminary work shows that the following lines 2351.50, 2175.72; 2056.71 classified by Bowen Millikan (Phy. Rev., Aug., 1926) as singlets are in fact closed doublets with constant frequency difference of 2·6 and the following lines observed by Rowland and Tetnall (Kayser Handbuch. d. Spectra) and not observed by Glasser (Ann. d. Phy. P. 73—78 1922).

3368. 54; 2987.295; 2986.91; 2899.09; have been obtained in addition to the lines 3111.83; 2738.88 which are new. All the wavelengths are in I. A. Vac.

80. On the emission of positive electricity from hot Tungsten in Mullard radio valves.

Phanindra Kumar Mitra.

1. In a Mullard radio-valve, as in all other forms of vacuum tubes, if the tungsten cathode be heated and a difference of potential be maintained between the cathode and the anode so that the cathode is negatively charged and the anode positively, then an electron current passes from the cathode to the anode which is a well-known phenomenon. But if the hot cathode is positively charged and the anode negatively, even then a current is seen to flow from the cathode to the anode, the direction of the current showing that it is of opposite sign to the electron current.

2. This positive emission can only be detected at a very high temperature which depends upon the type of valve used. A sensitive galvanometer of the order of 10^{-10} ampere per division is used to measure the current. The hot tungsten cathode is made the fourth arm of a Wheat stone bridge and its resistance is determined. Then from Langmuir's data showing the relation between the resistance and the temperature, the temperatures of the hot filament corresponding to different resistances are determined. Experiments show that emission currents from each tube are very similar and that they increase very rapidly with temperature, more rapidly than linear relation would indicate.

3. When the heating current is kept constant and the applied potential is varied, the current increases with the potential and then the increase of current diminishes and ultimately the current attains a saturation value. This value of the current is, however, different for different valves. It should be noted, however, that with a Coolidge tube, no saturation current could be obtained.

4. When a potential difference sufficient to produce the saturation value of the positive emission current is applied at first and then the heating current is switched on and kept constant, it is seen that while the negative emission current attains its full value in less than half a minute, the positive emission current grows slowly and gradually so that it requires from 3 to 6 minutes to reach its maximum value.

5. When the heating current is kept constant and a sufficiently high potential difference to give saturation value of the current is applied and maintained constant, it is found that the positive emission current decays with time. Experiments show that the precise form of the current-time curves varies from one specimen of the wire to another.

6. It is also seen that previous treatment of the valve plays a considerable part on the initial emission of positive electricity.

81. X-ray examination of the crystal-structure of Resorcinol.

A. N. SARKAR, Aligarh.

When 2 Hydrogens of Benzene are replaced by 2 Hydroxyls, three Isomeric compounds Catechol, Resorcinol and Quinol are formed. X ray Examinations of these Crystals were undertaken with a view to the confirmation of the structure of Benzene Nucleus determined by Sir William Bragg from the examination of Napthalene.

The present paper deals with the results of X-ray Examination of Resorcinol. The data obtained from the 'powder' photographs of this crystal were found to be insufficient for the determination of molecular structure but it has been found possible to obtain the space-group and relative arrangement of molecules.

X-ray Examination showed that $N=4$, Basic-lattice is Γ'_o both the planes of symmetry are glide-planes and the translations of the glide-plane are respectively equal to half the primitive translation of the symmetry plane, the axis of rolation is a simple axis of binary symmetry. The space-group is therefore C^{10}_{2v} and the molecules are asymmetric.

From certain observed accidental interference minima, not characteristic of group C^{10}_{2v}, certain relative arrangement of the four types of molecules in the unit all are deduced. The primitive set being situated at the eight corners of a parallelipepidon representing on unit cell, the molecules obtained by the operation $A(\pi)$ lie on planes parallel to (010) faces and passing through the middle of the b axis. The molecules obtained by reflecting the primitive set across the plane (010) lie at the points of intersection of the line through the centre of the cell (parallel to b axis) and the b (010) faces. The molecules obtained by reflecting the primitive set across the planes (100) at the centre of the cell. This arrangement satisfactorily accounts for the observed halving of (011) and (110) planes and few other abnormal reflections.

Sir William Bragg has published some work on this Crystal. My deductions as regards space-group and number per cell confirm his conclusions. I have suggested a different arrangement of molecules as I did not find the 4th order reflections from (100) and (010) planes.

82. Mechanism of coalescence in steels.

R. K. THAKORE.

The paper discusses the phenomenon of coalescence in alloys with special reference to coalescence of carbide in steel from the view point of theoretical physics.

Two assumption sare made viz. (1) slight solubility of carbide in Ferrite below the point A_1. (2) Diffusion in solid state subsequent to state of inequilibrium. Both are well supported by the well known researches of Benedicks, Robertsausten and others.

The part played by surface excess of solubility, stress, unequal size of particles, amorphous state in metals, metastable state in metals is discussed. Globurisation and subsequent coalescence of globules in the solid state is discussed from energy considerations based on the Gibbs—Thomson formula.

Observations showing that the accleration in coalescence in steels due to cold working is not primarily due to breaking up of cementite lamellae are recorded.

The paper contains a quantitative record of progress of coalescence of carbide in sorbitic steels, as measured by degradation of mechanical properties of steel.

83. The Optical anisotropy of some hydrocarbons of the paraffin group at different temperatures.

S. Ramachandra Rao, Chidambaram.

The method of determining the depolarisation factor of the transversely scattered light by liquids at different temperatures is given in a paper by the author in the Indian Journal of Physics, Vol. II, p. 8. In the manner shown in that paper, the optical anisotropy for pentane, hexane, and octane has been calculated at different temperatures. Krishnan (Proc. Ind. Assn. Cultn. Sc., Vol. IX, part IV, p. 251) has calculated similiar values for heptane on the experimental data of Martin and Lehrman. On plotting the optical anisotropy with temperature, it is found that the curves for these four liquids evince a regular gradation in their shapes.

On the basis of the theory recently developed by Prof. Raman and Krishnan regarding the anisotropy of the polarisation field in liquids, the constants of the field along three mutually perpendicular directions could be calculated. In the case of the paraffins, since the shape of the molecule is symmetric with respect to the longer axis of the molecule, we can take the constants of the polarisation field to be $p1$, p_2 and p_2. As the temperature of the liquid is raised, the free volume allotted for a molecule becomes greater and hence the anisotropy of the polarisation field is reduced. Thus as the temperature rises the ratio of p_2/p_1 tends to attain the value one. In the case of pentane, this value becomes one long before the critical temperature is reached; but in octane, the value does not become one even at about 30° below the critical temperature. This is just what one would expect from the fact that the length of the molecule increases from pentane to octane. The results afford a strong support to the theory of the anisotropy of the polarisation field in liquids. The calculations referred to above and the main conclusions will be published by a joint paper with Mr. Krishnan in a forthcoming part of the Indian Journal of Physics. The author's thanks are due to Prof. C. V. Raman for his kind interest and help.

84. A Laboratory method of determining e/m of thermions and the amplification factor of Triode valves.

Daulat Singh Kothari, Allahabad.

A triode valve with cylinderical anode is used. A suitable positive potential is applied to the anode, the grid being kept at zero potential. A uniform magnetic field is applied parallel to the axis of the anode and its strength increased, till the anode current just begins to decrease. Knowing the value of the field, anode potential, and radius of the anode it becomes possible to calculate e/m.

By applying known positive or negative potential to the grid, instead of keeping at zero as in the determination of e/m, the value of the amplification factor of the triode is found.

85. Some properties of dry liquids.

S. B. Mali.

Prof. Baker has recently shown that certain properties of liquids in the equilibrium state depend upon the presence of minute traces of insoluble impurities in the liquids. These impurities behave as catalylic agents in causing mutual transformations among the various components present in the liquids. The most common impurity in liquids is slight traces of moisture which it is very difficult to get rid of. The properties of liquids that we are acquainted with are but the properties of moist liquids which, according to Prof. Smits, are mostly binary mixtures. When moist liquids are subjected to intensive desiccation it is found that

certain of the properties of the liquids, e.g., vapour pressure, boiling point, surface tension and density are changed. In the present paper arguments are put forward in favour of the fact that other properties also of liquids, e.g., dielectric constant, electrical conductivity, light scattering power and refractive index, ought to change by drying and the direction of change also is predicted in some cases. The state of traces of moisture in moist liquids and the mechanism for catalylic behaviour of water in such liquids is also discussed.

86. The nature of the diffraction spectrum produced by a parallel beam of light incident on an inclined plane grating.

D. L. DASS, Gauhati, Assam.

When a parallel beam of light from a point source is incident on a plane grating normally inclined to the beam the various orders of the spectrum produced spread out in a line which can be viewed directly with the naked eye. This case has been investigated by Prof. Wood (Wood's Physical Optics, page 195). If however the inclination of the plane of the grating with the incident beam is changed the spectra assume a curved form, the curvature depending upon the amount of inclination. If the grating is inclined in the opposite manner, the sign of the curvature also changes. The present paper deals with the latter case in a more general form.

Supposing the direction of the ray before being incident on the grating to be horizontal and to be represented by the X-axis and Y and Z axes to lie in the plane of the screen vertically and horizontally respectively, the horizontal and vertical shifts of the points of maximum illumination (δ and δ') are connected with the inclination of the grating θ by a definite relation namely

$$\frac{Sin\ \delta}{Sin\ \delta' \mp Sin\ \theta} = \frac{m_1 \cdot b}{m_2 \cdot a}$$

where m_1, m_2, a and b are constants depending upon the dimensions of the grating and order of the spectrum considered.

First the intensity of illumination at any point on the screen is determined following Huyghens' wave theory of light. Then from the condition of maximum intensity the above formula is deduced. The results obtained by actual experiment are found to agree with the formula deduced within experimental errors.

Section of Chemistry.

President :—PROF. S. S. BHATNAGAR, M.SC. (PUNJAB), D.SC. (LONDON), F. INST. P.

Presidential Address.

THE PROGRESS OF PHYSICO-CHEMICAL RESEARCH IN INDIA.

INTRODUCTION.

To the mind of an Indian, Bengal still represents the intellectual province of India, and Calcutta the metropolis. Of the four Indians who have so far obtained the distinction of the Fellowship of the Royal Society of London, three have done the major portion of their work in Calcutta. As a shrine of learning in Chemistry this great city occupies a prominent, nay, almost a sacred position on account of its presiding deity, the celebrated and revered Acharya, Sir Prafulla Chandra Ray. It is therefore no mean honour to have been invited to preside over the Chemistry Section of the Indian Science Congress in Calcutta, the undisputed birthplace of modern chemical research in this country.

If a census were to be taken of all the Indian chemists who have published any original work and if they were asked to indicate the source of their inspiration, I believe the majority would ascribe the credit to Sir P. C. Ray. The one atrocious crime which I have committed and for which, I am sure, I have not been forgiven by Sir P. C. Ray, is that I am not his pupil. My defence is that I was not born early enough and hence I happen to be a grand-pupil of his, having received instruction in Chemistry from the late Mr. Atul Chandra Ghosh, one of his earliest pupils.

Being thus a comparatively young representative of a fairly well established family of chemists, I am justified in choosing as the subject of my address a brief survey of the progress of Research work in Physical Chemistry in India, and in choosing a subject of such immense scope I am only following the advice of Sir Richard Gregory who recommends that in such "parliaments of science" every sectional president should deal broadly with his particular branch of science in order that the general public and members of other sections might be in a position to appreciate all its implications.

THE LATE SIR ALEXANDER PEDLER, F.R.S.

The first recorded attempts to introduce modern physico-chemical research into India were made by the late Sir

Alexander Pedler, who came out to India in 1873 as Professor of Chemistry in the Presidency College, Calcutta. Before his arrival in India, he had distinguished himself in Chemistry under Frankland at the Royal College of Chemistry, then in Oxford Street, and from the optically active and inactive amyl alcohols, Pedler prepared the corresponding valeric acids and gave an account of his work to the Chemical Society in 1868. Pedler was a man of varied interests and he gave up his work in Organic Chemistry the same year and left for Sicily to take part in the solar expedition there. From 1871 Pedler served for two years as lecture-demonstrator to Sir Edward Frankland in the Royal College of Chemistry and at the same time he assisted in the research-work on gaseous spectra in which Frankland and Lockyer were jointly occupied. This naturally created in him a great deal of interest for the fascinating problems of astrophysics, and soon after his arrival in India he was put on special duty in connection with the eclipse expedition of 1875. To him the Calcutta University owes the introduction of a practical examination in the M.A. and the B.A. and B.Sc. degrees. He also examined and reported on the coal-gas and water supplies of Calcutta. It is interesting to know that Professor Ruchi Ram Sahni, the first M.A. in Chemistry from the Punjab (1885) obtained his training in gas-analysis under Professor Pedler; and he thus constitutes the first chemical bond between the two provinces.

As early as 1878, Professor Pedler published in the Proceedings of the Royal Society (27, 17) a paper on the poison of the cobra, a subject which was obviously suggested by the circumstances of his residence in India. In this paper Professor Pedler used the method of dialysis for the separation of crystalline and amorphous albuminous matter contained in cobra poison. The change in the properties of the poison on keeping, the determination of its physical constants such as density, etc., and its chemical composition were also described by him. Pedler also attempted to find a suitable antidote to the poison and, after many trials, discovered that platinum tetrachloride yielded excellent results as it produces a non-poisonous salt when injected into a live chicken. He thus suggested what might be called a real chemical antidote. This antidote was not tried on human beings as the toxic properties of the platinum salt were not then known. Professor Pedler evidently did not fail to see the wonderfully quick absorption of the poison by the blood and he suggested that, in order to counteract the effects of the poison, the antidote must also be as quickly absorbed.

In 1890, he contributed to the Journal of the Chemical Society three papers, which showed that he was utilising opportunities of studying the action of tropical sunlight on chemical

change. The first of these papers was entitled "The Action of Light on Phosphorus and some of the Properties of Amorphous Phosphorus." The second paper was on "The Action of Chlorine on Water in the Light and the Action of Light on certain Chlorine Acids." The third paper contained an account of attempts to estimate hydrogen sulphide and Carbon-disulphide in gaseous mixtures by explosion with oxygen.

Pedler was elected a Fellow of the Royal Society in 1892. He had evidently exhibited many qualities usually associated only with members of the Indian Civil Service, as one finds that he filled a number of very unusual appointments for a Chemist in this country. These appointments included those of—

Meteorological Reporter to the Government of Bengal for 22 years,
Principal of the Presidency College, Calcutta,
Vice-Chancellor of the Calcutta University,
Director of Public Instruction, Bengal.

He ended finally as an additional Member of the Viceroy's Legislative Council. In recognition of his public services he was created a C.I.E. in 1901, and in 1906, when he returned to England, he received the honour of Knighthood. On the outbreak of the Great War he took up duties connected with the Research Department of the Ministry of Munitions. Whilst attending a meeting of Committee at that office on Monday, May 13th, 1918, he was seized with a sudden illness and expired immediately.

At the end of his paper on the Cobra Poison published in the Proceedings of the Royal Society, 1878, Professor Pedler mentions the skill and devotion to research-work of his assistant Babu Poolin Behari Saor who may perhaps be considered as the first Indian connected with modern research work in Physical Chemistry. Another interesting name which may be recalled in connection with the teaching of Physical Chemistry is that of Professor J. Campbell Oman, F.C.S., F.L.S., who was appointed as the first Professor of Science in 1877 in the Government College, Lohore. He made a big reputation as a clever teacher whose lectures were profusely illustrated by interesting and successful experiments. He does not appear to have published any original paper from Lahore, although his skill in designing simple [illegible] new apparatus is still recalled in the Punjab.

S[illegible] C. Ray.

Meanwhile a young [illegible]i Professor was gradually but successfully building up [illegible]l of chemistry. The discovery of mercury nitrite and hy[illegible]e by Professor P. C. Ray had opened up a vast field of [illegible] capable of absorbing a host of workers, and one finds [illegible]umerous papers by him and his pupils on all aspects of this subject. The subject of Sir P. C.

Ray's researches did not strictly belong to the domain of Physical Chemistry, but we find the young Professor stimulating his younger pupils to collect physical data in ascertaining the constitution of mercury nitrite whose structure he had already postulated on purely chemical evidence.

The Early Chemistry in the Punjab.

At this time great educational strides were being made in the Punjab. Mr. Oman retired in 1897 and Professor Ruchi Ram Sahni, who had been on the staff since 1887 was appointed to act as Professor of Science. In 1898 Professor Hemmy took over the charge of the joint chairs of Physics and Chemistry at the Government College, Lahore. No great progress towards research-work in Chemistry was however made in the Punjab until 1906 when the single chair was divided into two—one for Physics retained by Mr. Hemmy, and the other for Chemistry, to which Mr. B. Mouat Jones was first appointed. He was assisted by Prefessor Ruchi Ram Sahni. Mr. B. M. Jone's arrival in the Punjab is a landmark in the progress of chemical research in our country. Under his supervision the laboratories were extended so that soon after his arrival in India he was able to publish in the Journal of the Chemical Society for 1908–1909, three interesting papers on the spontaneous crystallisation of solutions of some alkali nitrates, sodium sulphate, carbonate and thiosulphate.

Professor B. M. Jones was able to attract other young men to research-work and Professor P. G. Shah of the Forman Christian College, Lahore, (now in the Indian Finance Department) contributed a paper in collaboration with Professor Jones as early as 1913 on the spontaneous crystallisation of solutions of potassium chloride, bromide and iodide.

Professor Jones retired from the Indian Educational Service in 1912 on account of ill-health. In 1913 he was appointed to an Assistant Professorship in the Imperial College of Science and Technology, S. Kensington; joined up as a private in the London Scottish in 1914: became a Captain and Assistant Director of the Central Laboratory, G.H.Q. in 1915, a Major in 1918 and later in the same year, a Lieut.-Colonel and Director of the Laboratory, G.H.Q. He was [illegible]rice mentioned in despatches and was awarded the D[illegible] In 1919 he was made Professor of Chemistry and D[illegible] of the Edward Davies Laboratory, University College [illegible]erytswyth and is now Principal of the Manchester Coll[illegible] Technology—an institution which is [illegible]e of the finest c[illegible]nd in the British Empire.

The Indian Institute [illegible]cience, Bangalore.

Early in 1900 Professor [illegible]y was asked by the Indian Government to come out to India and advise on an educational

question of great importance. Jamsetjee N. Tata, a man of the widest sympathies and learning, and at the same time of great financial ability and enterprise, felt that it would be a great benefit to India, if an institution for post-graduate research of a scientific character could be established in the country, so as to open up careers for Indian students. To provide for the establishment of such an institution, he offered to the Indian Government, buildings, land and properties estimated to yield an annual income of £8,333, besides administrative expenses, rates and taxes, and an adequate sinking fund. Further the family of Mr. Tata guaranteed that for 10 years the property would yield this income. The capital value of these gifts was about £200,000. It was to advise on the best way of utilising this gift that Ramsay was invited by the Government of India.

A very vivid description of Sir William Ramsay's impressions of scientific education in India in 1901, and of his recommendations in connection with his visit to India, is contained in a letter which is dated the 19th February 1901 and is addressed to Professor Fitzgerald who very narrowly missed being his colleague on the same expert committee.

"Let me give you a brief sketch of what we saw and what I have recommended...................... The site I have fixed on is Bangalore. The climate is excellent, neither too cold nor too warm. It is 4,500 feet up, and there is a sort of fresh feeling like that on the top of a hill. There is a geological station there, an agricultural station, a college, such as exist in India. More about them hereafter. They offer a splendid site, 300 acres in extent, in the best part of the town, which is very open. They have £1,200 a year to play with, a sum which has fallen to the Mysore State as the result of a disputed legacy, and which they wish to spend for the good of the State. The revenues of Mysore show a huge surplus which can't be annexed by the Maharaja, for he has a private allowance of £150,000; also the Cauvery Falls, 40 miles from Bangalore, are being connected with the Kolar goldfields, 45 miles in the other direction, and the leads pass within 7 miles of Bangalore. They are going to begin with 4,000 H.P., but measurements show that for 8 months of the year 100,000 could be got. Lastly, there are endless deposits of iron ore, manganese, magnesia, etc., near, all of which might be exploited. So I have recommended Bangalore...... The Committee have asked me to nominate the first members of the staff and I have suggested names.

They will have to get out a lot of young fellows of a technical kind from home, as many as they can afford.......
....

The students will [illegible] selected by the heads of Colleges, at the rate of about [illegible] a year. They must be men who

show intelligence and grit. More will be sent than can be permanently kept; they will all get three months' trial. These fellows will almost all require 1 to 1½ year's chemical and physical work before they are much good. There is hardly any laboratory work done in India..........

Next, these members of staff must each take up some question of the development of some industry, and the utilisation of some natural product; each will associate with him some students as assistants, and they will develop the processes as far as laboratory work can do it. There is the £1,200 a year to draw on for large-scale experiments. I suggest that small works should be put up, so as to get beyond the laboratory stage. And, lastly, the Mysore Government out of its surplus should provide half the capital, on terms............

There are really no industries in India; any amount of raw material, easily got and cheaply worked; and there is no opening for any young men scientifically trained; unless openings are made. The colleges are wretched places as a rule, though here and there exceptions must be made, and the whole system is rigidly examinational like the London University. They are reaping the fruits of it in a number of cramming shops, miscalled colleges.........."

The scheme proposed by Sir William Ramsay was revised by a committee consisting of Professor Sir Orme Masson and Col. Clibborn, then Principal of the Roorkee College. Dr. M. W. Travers, F.R.S., the first Director of the Indian Institute of Science was appointed in 1906. Thus the far-sighted vision of the great Tata led to the founding of an institute which continues to be regarded as one of the best epuipped laboratories in the British Empire. There is no doubt that the initial organisation and equipment of the institute are due entirely to the devotion and self-sacrifice of Dr. Travers, whose contribution to the success of Indian Chemistry will probably be correctly estimated only by posterity.

The first batch of students was admitted to the Institute in July 1911 and Mr. (now Doctor) Ramesh Chandra Ray published a joint paper with Dr. Travers on Borohydrates in 1912. The Department of Physical and General Chemistry since the retirement of Dr. Travers has been under the direction of Dr. H. E. Watson and may be safely regarded as the biggest centre of research in Physical Chemistry in the combined presidencies of Bombay and Madras. Dr. Watson received his training for research under the master-experimenter, Sir William Ramsay and we find that in his early work in India he continued his researches in atomic and sub-atomic chemistry —the first few papers which he published from India (about 1914) being on the subject of electrical discharge in Helium and Neon and on the radioactivity of rocks of the Kolar goldfields. He has also worked with Collie and Smeeth on the spectrum of

cadmium in the inactive gases and he has done pioneer work in the domain of atomic chemistry in this country.

There is no doubt that the unfortunate incidents in the early history of the Indian Institute of Science delayed the onward march of progress in their research-work, but it is my firm belief that the generosity and far-sightedness of the great donor are sure to bear fruit under the improved conditions and with the cultivation of a wider outlook of research in the country.

The Central College, Bangalore, under the inspiring guidance of Professor F. L. Usher has maintained a high standard of research in Physical Chemistry. Professor Usher came out to India with an excellent record of work on a variety of subjects, more particularly on the important question of the mechanism of carbon assimilation in green plants (in collaboration with J. H. Priestley), and on the action of radium emanations on the elements of the carbon group (with Sir William Ramsay). In 1917 Usher and B. Sanjiva Rao published a paper on the determination of ozone and oxides of nitrogen in the atmosphere and later on he and R. Venkateswaran published a paper on the Potential of a Nitrogen Electrode. Usher's recent contributions on the nature of the interfacial layer between an aqueous and a non-aqueous phase and on electrokinetic behaviour and electrode potential are also noteworthy. The presence of such a prolific worker in Bangalore must have contributed much to the intellectual atmosphere created there by the existence of the Indian Institute of Science.

Dr. N. R. Dhar.

Amongst the pupils whom Sir P. C. Ray was able to attract was Dr. N. R. Dhar. He was evidently one of those chosen by him for accumulating physical evidence on the structure of mercury nitrite. Dr. N. R. Dhar's name first appeared in chemical literature in 1912 along with that of Sir P. C. Ray; and although in 1910, two years previous to Dr. Dhar's paper we find the record of a contribution by Mr. S. C. Mukherjee on the ionisation of mercury nitrite solution as examined by the cryscopic method, the credit for starting for the first time systematic research-work in Physical Chemistry by an Indian must go to Dr. N. R. Dhar. Since the year 1912 a steady stream of papers on a variety of subjects has flowed from his laboratory. Out of a total of over 150 papers published by Dr. Dhar, it is not possible to determine exactly which constitute his best work. The versatility of his mind has made him travel swiftly and with ionic agility in the field of Electrochemistry. He has traversed dark reactions throwing light on their secret and silent machinations. The warmth of his enthusiasm for research on chemical dynamics has not been

characterised by a low temperature coefficient showing that the activity in him is not due to absorption of radiation from without but that it is an intrinsic and intra-atomic property of the Dhar atom. During recent years Dhar became a convert to the creed of colloidal chemistry—a faith strongly advocated before him by J. N. Mukherjee and the present writer. In one respect colloidal chemistry resembles measles. Every worker in the field of Chemistry must have it and it is safer if it be early in life lest an attack in later life should prove more serious. The cause of the extraordinary virulence of this infection in Professor Dhar's laboratory at Allahabad is perhaps to be ascribed to this factor. The most notable contributions on colloids from his laboratory are on the subject of Adsorption and the Liesegang Rings. It has been frequently observed that sols can be more or less completely adsorbed and coagulated by freshly precipitated solids. Based on the foregoing observations, Dhar and Chatterjee put forward a hypothesis on the formation of Liesegang rings in which a layer of coagulated material is assumed to be followed by a space free from the precipitated material. Mercuric iodide rings, for example, in gelatine consist of a layer of coagulated and crystalline mercury iodide which is red, followed by a layer of colloidal mercury iodide which is yellow. The theory is somewhat akin to the views expressed by Bechhold and has been well received in certain quarters, prominence being given to it in Liesegang's new book on Colloidal Chemistry. It has also been criticised by Hatschek and others. As a matter of fact in 1922 K. K. Mathur of Benares and Bhatnagar working on the mercuric iodide rings in silica gel noticed that the yellow as well as the red rings of mercuric iodide consisted of crystals of the two well-known varieties of mercuric iodide and that the yellow region did not consist of coagulated material which is demanded by the Dhar hypothesis. It is becoming increasingly recognised that no one theory of the concentric-ring formation can be applicable to all the cases described in the literature on the subject.

Concentric rings have been obtained without any gel medium being present by the interaction of gaseous ammonia and hydrochloric acid and hydrogen-sulphide and chlorine in the University Chemical Laboratories, Lahore. Concentric rings have also been prepared by American workers by diffusion processes in such media as powdered sulphur, sand, cloth and filter paper.

In the field of photochemistry, Dhar was one of the earliest workers to show that photochemical reactions are characterised by a rather low temperature coefficient. His extensive investigations on the Kinetics and Energetics of chemical reactions have resulted in the enunciation of the "Von Halban—Dhar rule," according to which the lower

the order of a reaction (*i.e.* the true not the apparent order), the higher is its temperature coefficient. One notices with pleasure the efforts made during recent years by Dhar and his pupils in applying the methods of Physical Chemistry to bio-chemical and physiological problems.

Dr. J. C. Ghosh.

Dr. Dhar's initiation in Physical Chemistry was infectious and following his example J. C. Ghosh and J. N. Mukherjee enrolled themselves in the service of Chemistry as early as 1914-15. The field of physical chemistry to which Ghosh was first drawn was electro-chemistry. The founder of this branch of science Svante-Arrhenius has just passed away after a record of work second to none in the world. His forceful writings are a mine of information and his originality made him propound theories which form the very basis of modern physical chemistry.

Ghosh interested himself in elucidating the behaviour of strong electrolytes which were not amenable to treatment on the Arrhenius hypothesis and which had defied efforts of such intellectual giants as Van't Hoff, Rudolphi and Ostwald.

Ghosh's Theory (1918) on the abnormality of strong electrolytes created a stir in the scientific world when it first made its appearance. The hypothesis of complete dissociation of strong electrolytes postulated by Sutherland, Bjerrum and Milner had prepared the field for a warm reception of a theory of complete dissociation. Milner's treatment of his theory was extremely logical but he failed to demonstrate its advantages and the advanced mathematics involved deterred many chemists from attacking the subject. The clarity with which Ghosh demonstrated the superiority of his hypothesis over the ideas current at the time received for it a ready acceptance from such distinguished scientists as Planck, Nernst, Sir James Walker and G. N. Lewis. The theory has been subjected to very adverse criticism by Kendall and Partington on account of certain apparent defects in the mathematical presentation. but all of us who know Dr. J. C. Ghosh would unanimously repudiate any aspersions on the integrity of his character or any attempt to rob him of the credit of being the first to give a concrete shape to the theory of strong electrolytes on the concepts of complete dissociation.

Theories come and go but good ones always open up new fields of research and lead to the consolidation of the ground already covered. From that standpoint Ghosh's theory will always live as it has undoubtedly introduced a change in scientific thought and established the hypothesis of complete dissociation as far as strong electrolytes are concerned. Debye gave a better mathematical treatment of the theory of complete dissociation in 1923.

As a result of the investigations of Bronsted, Noyes and G. N. Lewis, it is now more or less generally accepted that the Milner-Ghosh-Debye theory of complete dissociation gives a satisfactory representation of facts at high dilutions. Nernst has recently drawn attention to the fact that the Debye theory fails entirely to account for the heat of dilution even in simple cases. In fact Nernst has reiterated in the latest German edition of his work his faith in Ghosh's treatment and considers that it contains the kernel of truth, though he argues that a modification of the theory is necessary.

Dacca enjoys the privilege of being an old centre of chemical research, mainly in Organic Chemistry, because of the excellent early work done there by the late Dr. E. R. Watson on Colour and Constitution, and by Dr. B. K. Singh on optical activity.

During recent years the laboratory of Dr. J. C. Ghosh at Dacca has contributed considerably towards an interchange of thought between the older and newer Universities of India, and a steady stream of papers mostly on the subject of photochemistry has been forthcoming from his laboratories. He has worked on some of the most important aspects of photochemistry. His recent contributions on the Relative Mass of a Proton and an Electron (1927) are of an interesting character as the experimental value of the ratio $\frac{M+m}{m}$ (where M is the mass of the proton and m that of the electron) is in agreement with the value obtained on Ghosh's equation. The wealth of imagination displayed by Ghosh and his school coupled with their strong mathematical inclination leaves no room for doubt that work of lasting importance is bound to be produced from Dacca.

The Advent of Colloidal Chemistry and the Indian Chemical Society.

The credit of initiating research-work in Colloidal Chemistry in India goes to my friend, Professor J. N. Mukherjee of Calcutta. Early in 1915 when the importance of this subject was just beginning to be realised he published a paper in the Journal of the American Chemical Society on the Electric Synthesis of Colloids. Since then he has attached himself with single-minded devotion to this subject and has contributed numerous papers—some of fundamental importance, which have secured for him a very prominent place as a Colloidal Chemist, particularly in the domain of the suspension systems. His paper with Dr. Papa-Constantinou in the Philosophical Magazine, 1923, on an Experimental Test of Smoluchowski's Theory of the Kinetics of the process of coagulation is a piece of careful work well-worthy of perusal by those who

work hot-haste with colloids not realising how delicate the systems are with which they are dealing. His contributions on the origin of the charge of a colloidal particle and its neutralisation by electrolytes cannot be passed over by any serious student of Physical Chemistry and, as experimental methods in Colloidal Chemistry get more refined, more and more importance will be attached to Mukherjee's modification of the method for measuring the electric charge on colloidal particles.

In the year 1919, Dr. J. N. Mukherjee went to England to work under Professor F. G. Donnan. C.B.E., F R.S., whose fame as a powerful exponent of thermodynamics and as a pioneer worker on surface phenomena had also attracted me thither. There we met—both similarly charged, fortunately one suspensoid and the other emulsoid, and thus became stabilised by our mutual action.

I crave your indulgence for a few minutes to disclose the account of a private conference which Dr. Ghosh, Dr. Mukherjee and I had in the year 1919 in the University College Chemical Laboratories in London. The subject-matter of our conference was the starting of an All India Chemical Society, with Sir P. C. Ray as its first President. We had a long discussion on the subject and afterwards we took Professor Donnan into our confidence and he fully approved of the plan. On our return to India out of the many plans which we made together and of all of which Dr. J. N. Mukherjee was to be the custodian, the one which he did not forget to carry out was the founding of the Indian Chemical Society. The President and the Secretary constitute the life and soul of a learned Society, and if one of them happens to be a colloidal chemist, the success of the society is by tradition ensured. Take, for example, the case of the Chemical Society, London, which we all recognise as the parent of our Indian Chemical Society. The first President of that Society was Thomas Graham, the father of Colloidal Chemistry. By a curious chance Dr. Mukherjee, who is the first Secretary of the Indian Chemical Society happens to be the father of Colloidal Chemistry in our country, and may we from this infer that our Society will have as glorious and as distinguished a record as the parent Society in London early discussions for whose establishment were also held in the University College Chemical Laboratories in London ?

The Indian Chemical Society has already played a great part and is bound to play a still greater part as times roll on in advancing the cause of chemical research in India. Two important and successful branches of the Society already exist—one in Lahore and the other in Bombay, lately established by the enthusiastic efforts of my friend and pupil Dr. Mata Prasad and Professors Meldrum and Normand.

NUCLEI OF PHYSICAL CHEMISTRY RESEARCH IN INDIA.

Sufficient has been said about the workers spread over the country who have devoted themselves to the service of physical chemistry. May I be permitted to sum up my observations by expressing the opinion that there appear to be at present in this country five definite centres of research in Physical Chemistry, namely, Calcutta, Dacca, Allahabad, Bangalore and Lahore. I am willing to call them by the flattering name of schools of chemistry as it is certain that the fire of enthusiasm lies deep at these centres and burns brightly. Mukherjee at Calcutta has gathered round him a band of enthusiastic workers and he is digging deep in colloidal and soil problems. Ghosh at Dacca with his numerous pupils notably Purkayesth, Bose and Mitter is carrying on the traditions early established there by the late Dr. E. R. Watson. Allahabad under the vigilant care of Dhar has been productive. Dhar's pupils, P. B. Ganguli and K. C. Sen, have achieved well-merited success. Bangalore under H. E. Watson and Usher, watched by Forster is flourishing. The trend of thought at these centres has been indicated by referring to their numerous publications. Regarding the nucleus of research in Lahore, it may interest you to know that the pioneering efforts to introduce research in Chemistry in the Panjab University curriculum are due to B. H. Wilsdon. In the year 1914, the visit of Professor Arthur Smthells, C.M.G., F.R.S., at the invitation of the Panjab University, gave a new stimulus to research-work in Chemistry. The detailed scheme was largely worked out by Wilsdon who also prepared the original plans for a University Chemical Laboratory, a fine site for which had been given by the Government, opposite the Mayo School of Arts. Wilsdon's excellent proposals, however, involved greater outlay than funds permitted. The existing building, architecturally one of the finest in Lahore, and in equipment and scientific amenity one of the best in India was constructed from the plans of the Government Architect, Mr. B. M. Sullivan, who designed this in consultation with Drs. H. B. Dunnicliff and B. K. Singh. The cost including equipment was about Rs. 5 lakhs.

Mr. B. H. Wilsdon was appointed Professor of Chemistry in the Government College, Lahore, in succession to Mr. Mouat Jones (1913) and during the next four years was actually engaged in preparing the ground for the foundation of an Honours School in Chemistry with a research subject as a post-graduate course. In 1917 he was lent to the Department of Agriculture, where, in addition to other problems, he devoted himself to the study of soil problems and achieved such distinction in his treatment of the subject that his services have been requisitioned by the P.W.D. (Irrigation Branch) as their Scientific Research Officer and as Secretary of the Water-logging

Committee. Besides these activities in the domain of applied physical chemistry, Professor Wilsdon has published in the Philosophical Magazine three important papers on molecular structure. This work (1925) was started at a time when atomic physics was struggling with the interpretation of spectra by means of half quantum numbers. The general thesis made was the enunciation of the principle that any combination of atoms must involve either synchronisation or harmonious relations between the frequencies of the two orbits forming a bond. In the simplest cases corresponding with singlet atoms it is possible to calculate the energy of formation of homo-polar and hetero-polar molecules. More complicated molecules were attacked on the analogy of the quantum mechanics of anomalous Zeeman effects. The polar bond was also considered on the basis of the Stark effects. The limitations to the development of a theory of chemical affinity along these lines are the same as confront the interpretation of spectra.

The first paper of the series afforded a basis for the discussion of the energetics of chemical combination in terms of our knowledge of electronic structure, and was the earliest attempt to apply the principle of spatial quantization to the problems of stereo-chemistry. A rational explanation was thus afforded for the two types of carbon linkage which X-ray investigations have shown to be associated with the alkyl or acid end of an ester.

The magnetic properties of atoms and molecules give an experimental method for studying the characteristics of valency orbits. A rational method of extending the principles developed in the previous papers to the calculation of both diamagnetism and paramagnetism was also found.

The school of chemistry in Lahore is fortunate in having men like H. B. Dunnicliff and N. A. Yajnik. Dunnicliff's extensive work on chemical equilibrium and Yajnik's numerous papers on molecular complexity and colloids are worthy of note. Dunnicliff has also to his credit an excellent record of technical research in connection with war-work. Mata Prasad who is now at the Royal Institute of Science was also associated with work done at Lahore. S. D. Muzaffar, who published work on alloys and the atomic weight of antimony and S. Krishna, whose passion for applying Physico-chemical methods to organic research is so well-known, are amongst the many who are associated with physical chemistry work in Lahore. Professor J. M. Benade of the F. C. College, Lahore, under whom I did my first work on Surface Tension has published valuable work with Professor K. T. Compton of Princeton on the collision of gas-molecules with electrons.

The work which I was privileged to do at Benares and more lately at Lahore, and which you have graciously recognised by inviting me to preside over your academic deliberations this

year, has been mostly on colloids, particularly on emulsions, photo-chemistry and the general properties of matter in the fused state. Our investigations, on the chemical nature of adsorption and protective action and on the Bhatnagar-Mathur Effect of water on dried silica gels which now find application in mining, for breaking the hard silica-bearing rocks are already known to you. Since 1925 I have been studying the influence of Radiation on micro-organism, and still more recently I have begun work on magneto-chemistry and on molecular structure.

According to the theory of atomic diamagnetism by Langevin, the atomic susceptibility is given by

$$X_{at} = -\frac{e^2}{4mc^2}\sum_n \bar{r^2} \dots (1)$$

where the letters have the usual significance.

Multiplying this by Avogadro's number (N) we get

$$X_{At} = -2{\cdot}85 \times 10^{10} \Sigma \bar{r}^2 \dots (2)$$

and for a molecule constituting an electronic isomer or an isomorphous body equation (2) may be written as

$$X_m = -2{\cdot}85 \times 10^{10} \Sigma (k\bar{r}_1)^2 \dots (3)$$

where $\bar{r}$ represents the value of the radius of the molecule calculated on the equation of closest packing from the values of atomic radii of constituent atoms after the method of W. L. Bragg. K is an arbitrary constant but in a series of electronic isomers or isosteres, it is found to exhibit variations depending upon the sum of the atomic numbers of all the atoms constituting the molecule. In all cases K is a function of the number of atoms constituting the molecules. On the above equation worked out in collaboration with C. L. Dhawan, it is possible to calculate values for the magnetic susceptibility of electronic isomers and for isomorphous substances containing atoms belonging to the same family in the periodic table The agreement between the calculated and the experimental value in most cases is excellent. It is interesting to note that K has an approximate value of 1 (0·8 to 1·184) for molecules containing 2 atoms. For molecules containing six atoms it is approximately 2 and rises continuously as the number of atoms in the molecule is increased.

More refined experimental work is required before much further progress in the theoretical interpretation of the magnetic properties of molecules is to be expected. This work is being carried out by S. L. Bhatia and Sham Lal. One significant question which crops up is whether a whole number rule for the magnetic moment holds for a molecule as it appears to do for an atom or ion. The effects of magnetic field on the Transport

number of paramagnetic ions and on the rate of chemical reactions have also been studied in my laboratory and it is definitely established that the rates of reduction of ferric-chloride solution containing hydrochloric acid, by Aluminium and Iron is accelerated and that by zinc retarded in a magnetic field.

In connection with molecular structure Tesla-Luminiscence spectra of a number of substances have been examined in collaboration with Dasharath Lal Shrivastava, Kailash Nath Mathur and Rama Krishna Sharma. Of these, that of iodine has so far proved the most interesting. In this we find that the spectrum extends much further into the ultra-violet region than the ordinarily excited band emission spectrum. Three systems of bands have so far been located and of these one system has been completely analysed according to the usual scheme of band spectra. The head of this system is a very prominent band over the identity of which, as the electron affinity spectrum, there has been considerable controversy. An examination of this spectrum under large dispersion is bound to be of great importance in the accurate determination of the term values. It has also been noticed that the Tesla discharge chemically affects most of the organic substances examined. Of these the substance obtained from naphthalene has been separated and attempts are being made to identify it.

We are very proud of the fact that this year's Nobel Laureate in Physics, Professor A. H. Compton of the Chicago University, whom the Panjab University had invited for stimulating physical research, worked in our laboratory for 5 months last year on X-rays and Vector Quanta assisted by Mr. Kailash Nath Mathur and Mr. Hari Ram. This work is being continued. He also had a scientific trip to Tosh Maidan in Kashmir to investigate the properties of cosmic rays in association with Ahmed, Benade and Bhatnagar.

It is not always possible to determine exactly how new ideas originate, or to assign to every contributor his just share of credit. With reference to this matter, all I can say is that I have used my best judgment upon the recorded evidence and I have endeavoured in all cases to be completely impartial.

Isolated Workers.

No survey of the progress of research in physical chemistry in our country could be complete without a reference to the activities of isolated workers. If these workers have not been able to create a school of chemistry round them, the circumstances under which they had to work are alone responsible. Much credit goes to them for keeping the torch of research alight under the difficult circumstances in which they found themselves. In this category we must give a prominent place

to the late Professor T. K. Gajjar. It was he who first advocated the cause of chemistry in the Bombay Presidency which is generally apathetic to newer pursuits particularly if they are not utilitarian. Professor Gajjar emphasised the importance of chemistry from the utilitarian as well as from the philosophical standpoint and there has been a response to his call although it is feebler than the appreciation given to Sir P. C. Ray, the pioneer of Bengal. Bombay has its Royal Institute of Science and one would have expected that as a business centre, as the focus of Indian imports, and with facilities for man and mechanical power, more use could have been made of it by those interested in industry.

Much of the responsibility of our hopes not being realised falls upon the shoulders of the Bombay University. Brought up at the shrine of oriental and classical learning, more attention has been devoted by it to arts and languages than to science. Of recent years a change for the better has been taking place, but nothing is more difficult than to dispel the superstitions of ages or to snatch your just share in academic administration from the hands of those who have wielded power in the past.

Professor A. R. Normand of the Wilson College, Bombay, is responsible for much of the work in physical chemistry in the Bombay University and it is gratifying to find that his students are maintaining the enthusiasm for work which Professor Normand brought with him from the laboratories of Sir James Walker. Dr. Mata Prasad's appointment in the Royal Institute of Science ought to stimulate physico-chemical research in Bombay.

In Agra Professor N. C. Nag started some research-work and later on established a reputation for himself as a clever analyst and teacher at the Benares Hindu University. He is now engaged with Sir J. C. Bose on research-work on carbon assimilation by plants under the stimulus of light. At Aligarh Dr. Qasim Ali Mansuri is continuing his excellent work on the constitution of intermetallic compounds and Professor Rane and Dr. S. K. Basu from Benares have also published work on general and physical chemistry. Dr. Ramesh Chandra Ray and Dr. K. S. Caldwell at Patna, Dr. A. N. Puri, the Soil Physicist in Pusa and Dr. Karve in Poona are maintaining the reputation of their cities as centres of teaching and research in physical chemistry. Under Dr. Cruickshank, Professor of Physiology in the Medical College, Patna, Dr. Trilok Nath Seth and Mr. D. L. Shrivastava, two of my former pupils and friends are doing good work on Biochemical problems. Dr. Trilok Nath Seth has published work of a high order from the laboratories of Professor F. G. Hopkin of Cambridge on physico-chemical methods applied to physiological problems.

In Allahabad Professor E. G. Hill who was appointed

Professor of Natural Science at the Muir College in 1895, kept up the work of research. Hill's original work in chemistry was directed partly to a study of some of the commercially important Indian products and partly to purely scientific problems of physical chemistry.

The first Indian product to attract his attention was the salty and alkaline earth which extended over considerable tracts in Northern India, making the land useless for the cultivation of crops. In 1903 he published a note on the analysis of the salts contained in the soil. A paper on "The Hydrolysis of Ammonium Salts by Water" in 1906 and another jointly with Dr. A. P. Sirkar on the Electrical Conductivity and Density of Solutions of Hydrogen Fluoride in the Proceedings of the Royal Society indicate the trend of his work in physical chemistry. He died on June 28, 1917 at Naini Tal and it was to his post that Dr. N. R. Dhar subsequently succeeded at Allahabad.

Dr. S. S. Joshi, one of my pupils at Benares and now working in the University College, London, under Professor Donnan, has also contributed notable work on chemical reactions under the silent discharge.

Dr. Abdul Hamid, a former pupil of Dr. Dunnicliff, the Second Chemist to the Archæological Department has published important work on the application of the Phase-rule to Heterogeneous equilibria.

It is evident from the survey just presented that almost all branches of Physical Chemistry are receiving attention in our country. From the nature of problems which are being studied by our researchers, it is clear that the standard of work is high and that we are capable of holding our own in the field of Physical Chemistry. The search for truth by the method of experimentation has begun and the era of hope has dawned.

The Happy Union of Physics and Chemistry.

It is time that the walls which divide our chemical and physical laboratories were broken down and that the young men and women who come to our Universities to study Physics or Chemistry should study the facts and principles of a fundamental science which includes both. The Union of Physics and Chemistry gave birth to the subject of Physical Chemistry and most happy results have accrued from this Union. Nobody will call me ambitious or partial to the subject which I profess were I to refer in this address to the very happy results which have been produced in our own country by this Union. I refer to the very important work done by Professor M. N. Saha and Professor C. V. Raman, both of whom have obtained the distinction of the Fellowship of the Royal Society. There are some here who may think that I wish to get the credit of

reflected glory to Physical Chemists by including Dr. Saha's name in my list. For their satisfaction I quote below a few lines from Astronomical Physics by Stratton (p. 30) on the work of Dr. Saha.

"An important step in the application of Bohr's theory to astrophysics was taken by Saha when he applied the equations of thermodynamics to the study of the ionization of a steller atmosphere as a function of its pressure and temperature. Assuming that the ionization of a gas—the dissociation of an atom into a positively charged ion and one or more electrons—is essentially of the same nature as a chemical reaction, he considered a reversible reaction of the type :—

$$\mathrm{Ca} \rightleftarrows \overset{+}{\mathrm{Ca}} + e - \mathrm{U}$$

where Ca, $\overset{+}{\mathrm{Ca}}$, e are gram-molecules of neutral calcium atoms, singly ionized calcium atoms and electrons respectively and U is the work expressed in calories, required to ionize one mol of calcium atoms. Following the methods of physical chemistry (quoting Dr. Stratton again), Saha has deduced an equation of the form :—

$$\mathrm{Log}\ 10 \frac{x^2}{1-x^2} P = -\frac{5050\ \mathrm{V}i}{T} + 2{\cdot}5 \log T - S$$

where X=the fractional number of the atoms of the gas which are ionized.

P=the total pressure of the gas.

Vi=the ionization potential of the gas (*i.e.* the potential through which an electron must drop in order to acquire sufficient velocity to ionize an atom with which it collides), measured in volts.

T=the absolute temperature of the gas.

S=the chemical constant of the electron=6.69.

Saha pointed out how the percentage ionization depended upon the temperature, the partial and total pressures, and the ionization potential of the gas."

The form of Saha's equation is certainly more familiar to the physical chemist than to the pure physicist. To get the best results the physical chemist ought to work in co-operation with the physicist, particularly with the mathematical physicist, supplementing the experimental skill which he needs and learning from him the methods of mathematical presentation.

The work of Professor C. V. Raman and his numerous pupils on the molecular scattering of light and his recent attack on the molecular structure of organic substances with Mr. Sogani by the method of X-rays constitute work which lies more in the domain of physical chemistry than in that of pure physics.

His recent activities in the field of magnetic properties of atoms and molecules and on the evidence of surface structure of molecules by measurement of surface polarisation with Ramanathan, and his skilful treatment of the Clerk-Maxwell Effect, show that he is interesting himself more and more in physical chemistry. His experimental and mathematical skill have won for him a place in the foremost rank of the scientists of the world.

The success of Professors Raman and Saha ought to be an object-lesson to the physical chemists in India, who should realise that with the imagination and the versatility of intellect which they possess, they could have achieved very much more if their mathematical equipment had been better than that provided for by the Indian Universities when they were students.

It is time that educationists in India recognised the importance of a better knowledge of mathematics for all students of physical science. The chemists themselves should come forward and learn mathematics and advocate improvements in the teaching of it in our University curricula.

OUR PROBLEMS.

The controllers of the purses of our Universities take great pride in putting up large and beautiful buildings. One University vies with the other in the matter of outward appearance but when the buildings are up, a large portion of the grant has to be spent on preserving their looks. And when the researcher wants more money for the work which alone should count, he is not infrequently treated like Oliver Twist in the Charity House, "he has asked for more." Recognising this tendency Sir Alfred Yarrow while handing over his munificent gift of £100,000 unconditionally to the Royal Society wrote as follows:—

"I should prefer that the money be used to aid scientific workers by adequate payment and by the supply of apparatus or other facilities rather than to erect costly buildings, because large sums of money are sometimes spent on buildings without adequate endowments and the investigators are embarrassed by financial anxieties."

Another serious menace which appears to threaten our academic life is the call on the time of researchers for unnecessary lectures, futile committee meetings and useless discussion. After receiving the Kober Medal on May 4th, 1927, at a session of the American Association of Physicians in the Atlantic City, Dr. W. H. Welch, the medallist, made the following pregnant remarks which we should all note:—

"Allow nothing to divert you from your professional and scientific work. While maintaining a spirit of co-operation, resist the call to give general addresses, especially at a distance

from home, to serve on committees, to undertake time-consuming administrative duties and to show visitors around laboratories and buildings."

Perhaps the greatest enemy which we have to fight is sloth. In the past it made us believe that the sum total of knowledge was included in our scriptures and that there was nothing new that one could discover. Hence India's youth perished from a disease diagnosed by General Spinola in the following anecdote:—

"Pray of what did your brother die?" Enquired the celebrated General from Sir Horace Vere. "He died," replied Vere "of having nothing to do." "Alas, Sir," said Spinola "that is enough to kill any General of us all."

With better understanding prevailing the demon of sloth has overtaken us in another manner. We start at a break-neck speed and when we have accomplished a little we begin to slow down and to rest on our oars. Applause which greets us when the race is started instead of spurring us to greater speed of action becomes the end and aim of a great many of us. May we all work to be the true investigators to whom

> "*Success is sweet, but the joy is in the doing;*
> *Not the end of journey but the travelling is*
> *What makes life worth while.*"

APPENDIX I.

Some Original contributions by persons associated with research-work in Physical Chemistry in India.

1878

Cobra Poison by Alexander Pedler. (Proc. Roy. Soc., 27, 17.)

1890.

Action of Light on Phosphorous: Properties of Amorphous Phosphorous by Alexander Pedler. (T. Chem. Soc., 599.)

Action of Chlorine on Water in Light; Action of Light on certain Chlorine Acids by Alexander Pedler. (T. Chem. Soc., 613; P. Chem. Soc., 65.)

Explosion of Hydrogen Sulphide and of Vapour of Carbon bisulphide with Air and Oxygen by Alexander Pedler. (T. Chem. Soc., 66.)

1903.

Analysis of 'Reh,' the Alkaline Salts in Indian 'Usar' land by E. G. Hill (P. Chem. Soc., 58.)

The Coloured Constituents of Butea frondosa by E. G. Hill. (P. Chem. Soc., 133.)

1906.

Hydrolysis of Ammonium Salts by Water by E. G. Hill. (T. Chem, Soc., 1273; P. Chem. Soc., 204.)

1907.

A New Colouring Matter from Nyetanthes Arbor-tristis by E. G. Hill and A. P. Sirkar. (T. Chem. Soc., 1501; P. Chem. Soc., 213.)

1908.

The Spontaneous Crystallization of Sodium Sulphate Solutions by Harold Hartley, Bernard Mouat Jones and George Ardian Hutchinson. (Jour. Chem. Soc. 93, 825.)

The Spontaneous Crystallization of Solutions of some Alkali Nitrates by B. Mouat Jones. (Journ. Chem. Soc., 93, 1739.)

1909.

Electric Conductivity and Density of Solutions of Hydrogen Fluoride by E. G. Hill and A. P. Sirkar. (Proc. Roy. Soc., A, 83, 130-148.)

Action of Radium Emanation on Elements of Carbon Group by Sir W. Ramsay and F. L. Usher. (Ber., 42, 2931.)

Influence of non-electrolytes on the Solubility of Carbon bisulphide in Water by F. L. Usher. (P. Chem. Soc., 303.)

The Spontaneous Crystallization of Solutions of Sodium Carbonate and Sodium Thiosulphate by B. Mouat Jones. (Journ. Chem. Soc., 95, 1672.)

1910.

Influence of Radium Emanation on Equilibrium in gases by F. L. Usher. (Chem. Soc., T., 389.)

1911.

Chemical Action of α and β rays individually and jointly by F. L. Usher. (Jaheb. Radioaktiv. Electronik, 8, 323-326.)

Mechanism of Carbon Assimilation, Part III by F. L. Usher and J. H. Priestley. (Proc. Roy. Soc., B, 84, 101-112.)

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Blue of the Copper Ammonium Complexes by S. S. Bhatnagar, Dina Nath and Mata Prasad. (Koll. Zeit., 1927.)
Surface Tension of some of the Organic Substances in the Molten State and the Sudgen's Parachors by S. S. Bhatnagar and Balwant Singh. (Journ. de Chemie Physique, 1927.)
Effect of the Dielectric Constant of the Medium on Equilibrium on Constants by K. Gopal, R. S. Gupta and S. S. Bhatnagar. (Indian Journal of Physics, 1927.)
Coagulation of Sols by a Mixture of Electrolytes and the Phenomenon of Positive and Negative Acclimatisation by S. Ghosh and N. R. Dhar. (Journ. Phys. Chemistry.)

APPENDIX II.

Books consulted.

1. Biography of Sir P. C. Ray.
2. Life of Sir William Ramsay by Tilden.
3. A History of Chemistry in the Panjab by H. B. Dunnicliff.
4. Scientific Journals cited above.

Section of Chemistry.

Abstracts.

1. Theory of Maxwell effect in liquids.

C. V. RAMAN *and* K. S. KRISHNAN, Calcutta.

Liquids under viscous flow exhibit birefringence. This effect, anticipated by Clerk Maxwell, has been fully established by the recent investigations of Vorlander and Walter (Zeits. Phys. Chem., Vol. 118, 1925, page 1) who have observed the effect in a large number of pure substances. On the basis of the ideas regarding the molecular constitution of liquids derived from the X-ray investigations of Prof. Sogani at Calcutta, the atuhors have developed a theory of the Maxwell effect which enables the magnitude of the effect in any liquid to be predicted in terms of the Boltzmann Constant, the viscous stresses, refractive index and density of the liquid and the constants of geometric form and optical anisotropy of its molecules. The theory gives values for the Maxwell-Constant in very satisfactory agreement with observation.

2. Comparison of the electrical changes of colloidal particles in presence of varying concentrations of non-electrolytes.

J. N. MUKHERJEE *and* N. RAO, Calcutta.

The experimental results recently published in the Jour. Ind. Chem. Soc. have been extended.

3. Coagulation and allied experiments with titanium hydroxide sol.

S. K. MAJUMDAR, Calcutta.

The stability of titanium hydroxide sol has been studied by the determination of the coagulation values of different electrolytes.

4. Experiments with the calomel electrode.

K. KUMAR, Calcutta.

The potential of calomel electrodes containing dilute solutions of hydrochloric acid are not reproducible. This has been shown to be due to a variation in the concentration of the acid as the result of some changes probably of the nature of adsorption.

5. The effect of non-electrolytes on the stability of colloids, Part III.

S. G. CHAUDHURY *and* N. CHATTERJEE, Calcutta.

Measurements of charge as well as coagulation experiments in presence of non-electrolytes in the case of copper ferrocyanide sol have been done and the facts explained in light of the views developed in the first two papers.

6. The effect of dilution of a colloid on its stability.

S. G. CHAUDHURY, Calcutta.

A theoretical discussion on the factors controlling the stability of colloids on dilution.

7. The effect of non-electrolytes on the stability of colloids, Part II.

S. G. CHAUDHURY *and* A. T. GANGULI, Calcutta.

Similar ideas (vide Part 1) have been advanced to explain experiments on coagulation of ferric hydroxide sol in presence of non-electrolytes.

8. Comparison of the electrical charges of different dilutions of colloidal solutions in presence of various electrolytes.

J. N. MUKHERJEE *and* A. BHATTACHARYA, Calcutta.

The experimental results recently published in Jour. Ind. Chem. Soc. have veen extended.

9. Electro-osmotic experiments with Kahlbaum's quartz sand in relation to the liberation of acids by the action of solutions of neutral salts on silica.

J. N. MUKHERJEE *and* S. MITRA, Calcutta.

In the matter of liberation of acids, quartz sand behaves differently from hydrolytic silica. An attempt has been made to explain the difference.

10. Further experiments on the nature of hydrolytic adsorption.

J. N. MUKHERJEE *and* J. K. BASU, Calcutta.

Experiments similar to those carried on with the sulphates of alkaline earth metals have been extended to insoluble silver and lead salts.

11. The effect of non-electrolytes on the stability of colloids, Part I.

S. G. CHAUDHURY, Calcutta.

Variation in the di-electric constants and surface tensions of the sols in presence of non-electrolytes affects the stability of colloids, the former changing adsorbability of the precipitating ion and the latter changing the critical potential.

12. The distinguishing features between adsorption by a substance in a hydrated and dehydrated condition.

M. P. VENKATARAMA IYER.

It has been found from measurements that benzoic, cinnamic, salicylic and stearic acids, which are generally dehydrated, show hardly any change in the *pH* values or the electrical charge when kept in contact with neutral salt solutions, whereas stearic acid which is highly hydrated in the colloidal state, shows marked changes in the *pH* values and the

charge when similarly treated. Dehydrated substances like the above adsorb their constituent ions very strongly whereas hydrated substances adsorb any ions without showing any strong preference for the constituent ions. Irreversible coagulation and charge reversals can also be satisfactorily explained on the above basis of adsorption by hydrated substances. Generally on coagulation, a hydrated colloid like stearic acid becomes dehydrated and loses its power of adsorbing ions from neutral salt solutions, and consequently the coagulation is irreversible.

13. Alco-Gel of silica.

BASRUR SANJIVA RAO *and* K. G. DOSS.

Adsorption by silica gel is ordinarily dependent on the water envelope in it; attempts have been made to obtain gel with an alcohol envelope. Experiments on the complete replacement of the water by alcohol, carried out by Graham, by Nanhauser and Patrick, and by Firth and Purse give contradictory results. The authors of this paper have extracted with hot alcohol, silica gel (placed in a Jena glass thimble) in a Soxhlet apparatus, the alcohol in the flask being kept anhydrous by addition of metallic calcium and barium oxide. On prolonged treatment the water in the gel was found to be about 1% by organic combustion methods suitably modified. Replacement of water was also attempted by a dynamic method in an apparatus in which air was continuously circulated in a closed system through anhydrous alcohol and the gel.

Adsorption curves for silica gel and water alcohol mixtures indicate that replacement of water becomes progressively difficult with decrease in water content of the gel. The authors tentatively conclude that complete replacement of water though it may not be impossible, is extremely difficult to effect.

14. Adsorption by silica gel from binary mixtures of liquids.

BASRUR SANJIVA RAO *and* H. M. CHANNABASAPPA.

Silica gel particles have a water envelope, and B. S. Rao (Thesis, London University, 1926) has shown that selective adsorption from binary mixtures of liquids is dependent on the energy of the interface that this water envelope forms with each of the two liquids. The interface between water and carbon tetrachloride has the same energy as that between water and carbon disulphide. The authors of this paper have determined at 30°C., adsorption by silica gel from mixtures of carbon tetrachloride and carbon disulphide in different concentrations and find in conformity with the above view, no selective adsorption.

Determinations were carried out in two ways: by a static method in which the gel was treated with liquid mixtures in a thermostat and by a dynamic method in which air bubbled through the liquid and passed over the gel in a closed system, the circulation of air being effected by a double action pump of special design, working in an air thermostat and consisting of two pulsating mercury columns and four mercury valves. A Pulfrich refractometer was employed for the analysis of the mixtures.

15. Application of the Donnan membrane equilibrium to the determination of adsorption of ions.

S. KRISHNAMURTI *and* P. B. GANGULY.

A method is described by which the amount of hydrogen ions from hydrochloric acid adsorbed by specially prepared colloidal silicic acid is measured by using the Donnan membrane equation for a semipermeable membrane In such a membrane it is supposed that a dialysable ion, through adsorption to a non-dialysable colloidal particle becomes non-

dialysable. From the Donnan equation an expression for the adsorbed quantity can be obtained, and using this expression, the quantity of adsorbed ions has been determined by measuring the membrane potential and activity of ions across the membrane.

16. Adsorption of acids by silica.

M. P. LAKHANI, Karachi.

In view of the controversy between Joseph and Mukherjee (Nature, March 28, 1925; Jan. 2, 1926; Dec. 18, 1926) it appeared as if the method of preparing silica determined whether it would adsorb acid or not. Calcium silico-fluoride and H_2SO_4 mixtures were distilled at low heat. The gas was collected under water. The precipitate of silica thus formed and dialysed for seven days did not adsorb HCl or H_2SO_4 as indicated by analytical, Electric Conductivity and P_H determinations.

17. Alumina gel as a desulphurising agent in petroleum refining.

JOGENDRA KUMAR CHOWDHURY *and* RAMESH CHANDRA BAGCHI.

This paper deals with the suitability of alumina gel for removing sulphur compounds dissolved in petroleum oils by means of adsorption.

Sulphur in the oil has been estimated by the lamp method, modified to give concordant results.

Optimum conditions for the activation of the gel; e.g. temperature of roasting and moisture content have been determined. Influence of other factors such as concentration and nature of sulphur compounds in the oil, quantity of the adsorbent, size of particles and temperature of treatment on adsorption, has also been studied. Freundlich's adsorption isotherm has been found to be satisfactorily applicable.

The majority of sulphur compounds have been almost completely removed by oxidation with dry atmospheric air, using alumina gel as a catalyser and subsequent filtration through the adsorbent. This is an improvement on the present process of oxidation with sodium hypochlorite.

It has also been found that intimate mixtures of alumina gel with other adsorbents such as activated carbon or silica gel, specially the latter, mutually promote the adsorption capacity to a remarkable extent. This is similar to the action of "promoters" used in the preparation of catalysts.

18. Emulsification at interfaces by an electric current.

M. P. VENKATARAMA IYER *and* P. B. GANGULY.

A series of measurements with various polyiodides have been made to elucidate the exact mechanism of the phenomenon of emulsification at the interface between nitrobenzene and water containing a polyiodide. It has been found that the necessary condition for this emulsification is the formation of the complex polyiodide ions both in the aqueous and the non-aqueous phases. The migration velocities of the polyiodide ions have been measured and it has been found that these ions are highly hydrated. An explanation of the emulsification effect is suggested based on the hydration of the polyiodide ions. An appreciable amount of heat is developed during the emulsification, which can be explained on the basis of the change of free energy of the water molecules at the interface.

19. Petrol-water emulsions.

C. Varadhan.

An attempt has been made to prepare a stable emulsion of petrol and water containing a large percentage of petrol for use as a fuel in internal combustion engines. A premier colloid mill was used for emulsification and a number of soaps were tried as stabilizers. The highest concentration of petrol reached was 65 per cent. The time and mode of separation of petrol-water emulsions made with the various stabilizers have been studied. Both the oil in water type and the water in oil type of emulsion have been obtained with every one of the stabilizers used and the inadequacy of the modern adsorption film theory to explain this has been discussed in the light of this and other investigations. The drop numbers of the stabilizers used have been determined at three concentrations and the stabilizers have been arranged in the order of their efficiency.

20. Coagulation of blood and milk by electrolytes and the clotting of blood.

N. R. Dhar *and* Satya Prakash, Allahabad.

1. Diluted blood and milk are more stable than concentrated blood and milk towards sodium, their coagulation by sodium citrate, sodium tartrate, sodium acetate, potassium oxalate and potassium fluoride.
2. In presence of small quantities of the above salts both blood and milk are stabilised because the adsorption of the negative ions and consequent increase in the negative charge.
3. Blood and milk behave abnormally towards dilution and a mixture of electrolytes and are likely to show the phenomenon of acclimatization.
4. The clotting of blood is guided by the same laws as the formation of jellies of vanadium pentoxide, ceric hydroxide, silicic acid, etc.

21. The influence of electrolytes on the coagulation of ceric hydroxide hydrosol heated to different temperatures.

A. R. Normand *and* M. C. Muthanna, Bombay.

The coagulating powers of the chlorides of alkali metals and metals of the alkaline earths on positive ceric hydroxide hydrosol, heated to different temperatures, have been studied. The time required for each electrolyte to coagulate the sol was followed by means of a potassium photoelectric cell. The order of the coagulating power of the electrolyte was found to change with different degrees of dehydration of the sol.

1. The order of the coagulating power of the electrolytes with sol dialysed at 28°C. is

$$LiCl > NaCl > KCl > RbCl.$$

2. With sol dialysed at 28°C. and heated to 70°C. is

$$LiCl > NaCl > RbCl > KCl.$$

3. With sol dialysed at 28°C. and heated to 100°C. is

$$KCl > RbCl > LiCl > NaCl.$$

Thus it is seen that the coagulating power of the different electrolytes depends upon the temperature condition of the sol. Thus the sol at 28°C. and 70°C. was most sensitive to LiCl and least sensitive to RbCl and KCl; but at 100°C. it was most sensitive to KCl and RbCl and least to NaCl and LiCl.

22. On the coagulation of thorium hydroxide sol by electrolytes.

B. N. DESAI.

The influence of electrolytes on colloidal $Th(OH)_4$ has been studied under different conditions.

It is observed that the Smoluchowski theory for the kinetics of coagulation holds only up to a certain concentration of the coagulator. With increase in dilution of the coagulator the coagulation velocity curves become more and more 'S' shaped and with their appearance, the Smoluchowski theory seems to be inapplicable. The 'S' shaped nature of the curves indicates that the process of coagulation is autocatalytic.

Coagulation of $Th(OH)_4$ sol by LiCl and $BaCl_2$ has been studied with the progress of dialysis. It is found that a sol containing appreciable amounts of the peptising agent behaves abnormally to the dilution rule and that the velocity curves for equivalent concentrations of LiCl and $BaCl_2$ are not concurrent. With the progress of dialysis the applicability of the Schulse-Hardy law increases. The abnormality to the dilution rule, as is seen from these experiments, is due to adsorption of the similarly charged ion as well as to the increase in the distance between the colloid particles on dilution of the sol and the former being the deciding factor.

Coagulation with different pairs of electrolytes has also been studied and ionic antagonism is observed in those cases where similarly charged ion is adsorbed to an appreciable extent. It is definitely seen that the antagonistic behaviour is not due to decrease in the adsorption of one precipitating ion owing to the presence of the other.

23. Studies on the formation of silver sol prepared by dispersion in the electric arc—II.

P. S. MACMAHON *and* S. C. VARMA, Lucknow.

In connection with the previous paper ("Action of light on silver bromide" by P. S. MacMahon and A. C. Chatterji) attempts were made to determine the properties of finely dispersed silver. A method for preparing this material was published in the meantime by Furth (Koll. Z. 34. 224, 1924) who obtained a deposit from an electric arc struck in air between silver electrodes which gave a sol on treatment with water. We have observed that this deposit is by no means pure silver: it contains large quantities of oxide and nitrate. On igniting the dust, brown fumes are given out in perceptible quantity.

The dust has been prepared by us by striking the arc between pure silver electrodes in either air, oxygen, or nitrogen. Nitrate was found to be produced in oxygen containing as little as 0·2% nitrogen. The same result was obtained in nitrogen containing a little oxygen. In pure nitrogen practically no deposit was formed and it is probable that if the gas were chemically dry there would be no formation of dispersed silver whatever.

The conditions under which the sol was produced by the addition of water to the powder was studied at length, and the results are discussed in the paper.

The properties of the solid powder were also investigated. There is evidence that this powder exposed to air or oxygen takes up a further small quantity of oxygen, indicating the oxidisation of finely dispersed silver.

24. Sensitization of sols of prussian blue and Odèn sulphur by gelatine and tannic acid.

SATYESHWAR GHOSH.

(1) Experimental results show that a sol of prussian blue is rendered slightly unstable towards its coagulation by KCl and $BaCl_2$ in presence of gelatine. The sensitizing effect passes through a maximum and when larger quantities of gelatine are added the sol is stabilised. With HCl the sensitizing effect of gelatine is more pronounced than in cases of KCl and $BaCl_2$.

In presence of small quantities of tannic acid prussian blue is sensitized in its coagulation by KCl, whilst there is appreciable stabilisation of the sol when coagulated by HCl.

(2) Odèn sulphur sol has been found to become unstable in presence of gelatine towards KCl and $BaCl_2$. Odèn sulphur sol can be readily coagulated by gelatine.

Tannic acid renders Odèn sulphur sol stable towards electrolytes.

My experimental results show that Odèn sulphur sol is stabilised in presence of acid and rendered unstable in presence of alkali. Moreover, I have shown that the coagulating power of sodium and potassium salts of weak organic acids towards Odèn sulphur sol decreases with increase in their dissociation constants. These results can be explained from the point of view that pentathionic acid which is the stabilising agent in Odèn sulphur sol, is stabilised by acids and is decomposed by alkalies. Boiling renders Odèn sulphur sol unstable.

The deviation of ions of different valencies to follow the Schulze-Hardy law in the coagulation of Odèn sulphur sol is caused by the presence of acids derived from the hydrolysis of the salts.

(3) The sensitizing influence of small quantities of OH^1 ions in the coagulation of sols of silicic acid, tungstic acid, molybdic acid, etc., is due to the decrease in the amount of the complex negative ion present.

(4) The experimental results so far obtained by us as well as by other investigators on the sensitization of sols by gelatine, albumin, tannic acid, etc., can be satisfactorily explained from the following considerations :—

(*a*) Checking of hydrolysis of sols by H° ions present in the sensitizers.

(*b*) Charge reversal of the sensitizers due to the presence of H° ions present in the sols.

And (*c*) Neutralisation of charge of the sols by the oppositely charged sensitizers.

25. Tungstic acid hydrosol.

A. R. NORMAND *and* M. C. MUTHANNA, Bombay.

It is stated that tungstic acid sol is indifferent to acids, salts and alcohols. But a fairly sensitive sol has been obtained by peptising the tungstic acid both with an acid and an alkali. The sol of tungstic acid prepared in either of these ways is negatively charged and has the characteristic properties of an emulsoid sol.

The coagulating power of the electrolytes on the sol has been studied with the aid of the photo-electric cell. The order of coagulating power of the chlorides of alkali metals is of the order

$$RbCl > KCl > NaCl > LiCl.$$

The protective influence of the negative ions is as follows :—

$$Cl \angle Br \angle I.$$

26. On a reversible photochemical reaction between bromine and m-nitro-benzylidine malonic ester in carbondisulphide as solvent.

J. C. GHOSH, K. P. BASU *and* S. BHATTACHARYYA, Dacca.

The velocity of bromination of m-nitro-benzylidine malonic ester in the dark is almost nil, the reaction however, proceeds fairly quickly under strong illumination. The resulting dibromide does not decompose in the dark but with bromine as photosensitiser, dissociation of the dibromide into bromine and the original ester takes place in light. It has been found that the rate of photobromination is given by the equation :

$$\frac{dx}{dt} = k_1 I.(a-x)\,(b-x)$$

where I is the intensity of illumination, a, b are the concentrations of the ester and bromine respectively. The rate of dissociation of the dibromide is given by

$$k_2\sqrt{I}.x.$$

The observed velocity of photobromination is the difference between these two rates and is given by

$$k_1 I\,(a-x)\,(b-x) - k_2 x\,\sqrt{I}.$$

The equilibrium constant

$$k = \frac{x}{(a-x)\,(b-x)} = \frac{k_1 I}{k_2\sqrt{I}} = \frac{k_1}{k_2}\sqrt{I}.$$

It is clear that the equilibrium constant increases as the square root of the intensity of illumination. This has been actually found to be the case.

27. The influence of the intensity of incident light on the velocity of some photochemical reactions.

B. K. MUKHERJI, Allahabad.

In all fifteen reactions have been studied from this point of view. It has been observed generally that the velocities of the reactions containing iodine as one of the reactants vary proportionally to the square root of the intensity of the incident light. Some reactions have also been noted whose velocities vary proportionally to the squares of the intensity. In 5 cases direct proportionality between velocity and intensity has been established. The variation of the velocity with the square root of the intensity of the incident light is explained by assuming that in all reactions involving iodine as the photo-active constituent, the chemical changes take place between atoms of iodine. The dependence of the velocity of the reaction between mercuric chloride and ammonium oxalate on the intensity of incident light (the former changing as the square root of the latter) is explained by supposing that photochemically the Hg_2Cl_4 molecules break up into a pair of $HgCl_2$ molecules before reacting. In general, it has been concluded that reactions which are really photochemical in nature are proportional to the square root of intensity. Whereas, those reactions which are not markedly photochemical in nature should be proportional to powers greater than unity of the incident light.

28. The action of light on silver bromide—I.

P. S. MACMAHON *and* A. C. CHATTERJI, Lucknow.

Pure silver bromide was sealed in a tube containing pure precipitate of gold as absorbent for bromine in an atmosphere of dry oxygen and ex-

posed to sunlight for lengthy periods. Absorption of oxygen in all cases took place in approximately the same amount as that observed in the case of silver chloride.

It is suggested by the authors that the phenomenon is not due to photochemical synthesis of an oxy-compound, but that it is due to the direct absorption of oxygen by the dispersed silver produced in the photochemical decomposition of the silver halide.

29. Oxidation of carbohydrates, fats and nitrogeneous substances by air in presence of sunlight.

C. C. PALIT, Allahabad.

1. Solutions of galactose, arabinose, cane sugar, glucose, laevulose, lactose, maltose, starch, glycogen, urea, glycine, alanine, hippuric acid, sodium urate, potassium palmitate, and potassium oxalate have been oxidised by passing air in presence of sunlight.
2. It has been found that the greater the intensity of sunlight, the greater is the amount of oxidation.
3. Zinc oxide acts as a marked photo-sensitiser in the above oxidations and in its presence the amount of oxidation in each case is greater than in its absence.
4. It is probable that by the absorption of sunlight, the cells in the animal body are activated and this activation leads to a greater amount of oxidation of fats, carbohydrates, and proteins. Hence sunlight and other kinds of artificial lights prove efficacious in the treatment of diseases specially of metabolic origin.

30. The limits of applicability of Fresnel's law and evidence in favour of surface structure from surface reflectivity.

S. S. BHATNAGAR, D. L. SHRIVASTAVA *and* N. G. MITRA, Lahore.

This paper describes an investigation on the surface structure from a study of the energy in the reflected ray from a liquid surface. The liquids examined were some organic acids, alcohols, esters, hydrocarbons and amines both in the aliphatic and aromatic series, as also some colloidal sols and solutions of inorganic substances. The limits of applicability of Fresnel's formula, calculating the energy of the reflected ray, have been explored, as it postulates uniform arrangement of molecules both in bulk and on the surface, which is contrary to Langmuir's hypothesis. It has been noticed that Fresnel's law is obeyed at higher angles of incidence of the reflected ray but at the smaller angles the variation is $\pm$ 5% in cases where the substances are aliphatic and have the polar groups. This may be taken as an evidence in favour of a distinct arrangement of a layer of molecules at the surface.

31. The Tesla-luminiscence spectra of Iodine and Bromine.

S. S. BHATNAGAR, D. L. SHRIVASTAVA, K. N. MATHUR *and* R. K. SHARMA, Lahore.

The emission spectra of Iodine and Bromine excited by electrodeless discharge from a Tesla transformer have been examined by a quartz spectrograph. Some new bands have been noted in the ultra-violet region. The continuous background has been noted to end sharply at λ 2130 for iodine and λ 2125 for bromine. An explanation based on the electron affinity and the dissociation potential of the molecule has been put forward.

32. The Tesla-luminiscence spectra of some organic solids.

S. S. Bhatnagar, D L. Shrivastava *and* R K Sharma, Lahore.

The tesla luminiscence spectra of naphthalene, anthracene, phenanthrene, camphor, menthol, etc., have been examined with a quartz spectrograph at the ordinary room temperature.

33. On the possibility of isotopes in Ra emanation.

Nazir Ahmad, Lahore.

It was noted by early workers that the period of Ra emanation, as found by the X-ray method, was generally smaller than that found by the X-ray method. It was thought by the writer that this difference was probably due to the presence of two or more isotopes in Ra emanation, their periods of decay, being a nuclear property, having different values. To test this point, two nearly equal samples of emanation, one fresh and the other old, were balanced against one another, the balance being maintained by means of a uranium resistance. The emanations were allowed to decay for several days, the balance being tested from time to time by means of the sensitive Compton electrometer. No difference in their rates of decay was observed within 1/500 which was the limit of accuracy of the experiment. The differences in the results of the early workers therefore could not have been due to the presence of isotopes but to some other hitherto unexplained cause. The experiments were performed at the Cavendish Laboratory under the guidance of Sir Ernest Rutherford.

34. Cosmic radiation and radio-activity.

J. M. Benade.

Tests of the rate of discharge of an electrometer due to the presence of radio-active material in an ionization chamber was found to be unaffected by variations in the intensity of cosmic radiation. A self-recording electrometer was submerged in the Dal Lake in Kashmir.

35. Radio-active Columbite from Gaya district: chemical and physico-chemical examination.

N. C. Nag, Calcutta.

Complete analysis of Indian Radio-active Columbite seems not to have been attempted. The present investigation gives the proportions of the various constituents present in a sample of Gaya District Columbite, supplemented by electroscopic determination of Uranium content (and hence of Radium) by comparison with a sample of standard Joachimstahl Pitchblende (thorium free).

Specific gravity of a piece weighing 55·956 grams was found to be 5·46 with an approximate hardness of 6.

Niobium Pentoxide	59·05 %
Tantalum Pentoxide	19·85 %
Ferrous oxide	7·90 %
Ferric oxide	0·22 %
Manganous oxide	11·62 %
Cupric oxide	0·15 %
Uranium oxide U_3O_8	0·80 %
Moisture	0·24 %
Silicon, lead and bismuth oxide	traces only.
Total determined	99·28 %

Electroscopic determination supported chemical estimation. Geological work by the Geological Survey of India and of Mysore, and electroscopic work by Yajnik and Kohli (Journal of the Asiatic Society of Bengal) have been referred to.

36. Magnetism and molecular structure, Part I: the magnetic susceptibilities of some inorganic sulphides and electronic isomers.

S. S. BHATNAGAR *and* S. L. BHATIA, Lahore.

In this paper the authors have determined the magnetic constants (at the room temperature) of the yellow and red sulphides of arsenic (solids) and also of their colloidal solutions in water. The determinations have been made with a modified Wilson's magnetic balance. The results show that Realgar (As_2S_2) is less dia-magnetic than orpiment (As_2S_3) both in the solid form as well as in colloidal solutions. These differences have been explained on the basis of atomic structure, and the valency theory of Langmuir. Work on other sulphides is discussed.

37. A note on isotopes.

SATYENDRA RAY, Lucknow.

It is presumed from the "fine structure" of Thomson's parabolas that m for an atom is variable. Experimentally, however, all that we obtain is a change in the ratio e/m for an atom and the assumption that e is constant leads to the inference that m is variable.

Daecke in Phil. Mag. and Zeit. f. Phys. shows that statistically, the value of the electronic charge e is 1/19 (=1/20 nearly) of the value given to us by Millikan. If we accept the possibility of the electronic charge being different from the value of Millikan, Aston's results may be taken to prove experimentally that the atom of electricity is, at least, 1/10 of that given by Daecke or 1/200 of that given by Millikan, rather than that the "atom of matter" possesses a variable mass.

38. Avogadro's number and "mean free path."

SATYENDRA RAY, Lucknow.

Millikan calls the mean free path a "hypothetical" quantity. It is shown that this mean free path is not related in any intimate manner with the properties of a gas like volume, pressure, temperature or entropy, if the expression usually accepted for it, viz. $\lambda=\frac{1}{\sqrt{2}\,\pi N\sigma^2}$ be correct. It is shown, instead, that the fairly close agreement of the Avogadro's number for different atoms means that the size of atoms is very nearly identical and that perhaps $\lambda=\left(\sqrt[3]{\frac{N}{3}}-\sigma\right)$ is a more correct expression for the mean tree path that the one usually accepted, which makes value of λ infinite when size of particle is infinitely small.

39. Fresh evidence in support of the chemical theory of fluorescence.

S. S. BHATNAGAR *and* KRISHNA GOPAL MATHUR, Lahore.

In support of the Perrin's view of the chemical nature of fluorescence, small changes in the refractive indices of eosin, fluorescein and acriflavin in their aqueous solutions have been observed on exposing

them to a concentrated beam of light from an arc lamp. The changes in the refractive indices when determined by means of the Rayleigh Interference Refractometer, by which a change in the refractive index of 1 in 100,000 could be ascertained with accuracy. Experiments were performed at various molecular concentrations, and the values obtained for the changes in the refractive indices were found to diminish at higher concentrations as the intensity of the fluorescent light decreased. Effect of the presence of gelatin and caustic soda has also been studied and in the presence of these substances the values for the changes were again observed to diminish, evidently on account of their retarding influence on the photo-decomposition of these fluorescent substances. Further work on the changes of other physical properties of the fluorescent substances on strong illumination and the influence of viscosity on their photo-decomposition is in progress.

40. Vapour pressure of the soil.

RATTAN CHAND HOON, Lahore.

Experiments are described investigating method by which the relationship between the moisture contact of a soil and its equilibrium vapour pressure may be determined by both a static and a dynamic method involving the use of the quartz spring micro-balance.

41. Experiments on the hygroscopic-coefficients of thin films of colloidal matter.

MUKAND LAL, Lahore.

A method of measuring hygroscopic capacities of the colloidal fractions of soils is described when a microbalance in which Poyntings' double suspension mirror is employed.

Experiments, showing the influence of darkness, light and the various parts of the spectrum on the hygroscopic capacities of colloidal materials have been conducted with the object of testing results described by Linford 'Soil Science,' Vol. XXII.

42. Reproducibility of hydrogen-calomel cells with low concentration of hydrochloric acid.

J. N. MUKHERJEE *and* K. KUMAR, Calcutta.

Abnormal values of e.m.f. are observed for such cells with dilute solutions of hydrochloric acid. According to Ellis (J.A.C.S., *38* (1916), p. 737) it is due to formation of basic chloride or sub-chloride and that the error is so large in solutions of HCl below 0·01 N "as to render measurements at these concentrations valueless." The present authors have observed that the process of equilibrium between a dilute solution of hydrochloric acid and calomel-mercury paste is very slow and that hydrochloric acid is adsorbed by the paste, causing a high value of e.m.f. of such cells.

43. Evidence in favour of the existence of silver chromate in gelatine in the colloidal condition: electric conductivity of silver chromate in gelatine—II.

A. C. CHATTERJI *and* S. C. VARMA.

1. In a recent paper, Bolam and Mackenzie (Trans. Faraday Soc., *67*, 160, 1926) have contested the conclusion of Chatterji and Dhar (Kolloid Z. *35*, 2, 89, 1925) that Silver Chromate exists in the colloidal condition when precipitated in gelatine.

2. They reaffirm the conclusion of Williams and Mackenzie (J.C.S. 117, 844, 1925) that Silver Chromate exists in the ionic state in gelatine solution and does not behave as a protected colloid.

3. Experiments have been undertaken to determine accurately the electric conductivity of Silver Chromate of different strengths in gelatine of varying concentrations at 35°C., the silver chromate being produced by the addition of an equivalent quantity of silver nitrate and potassium chromate.

4. The results confirm the conclusions arrived at in previous papers (Proc. Ind. Science Congress, 1926; Trans. Faraday Soc., *72*, 23, 1926). Moreover, the experimental evidences of Bolam and Mackenzie from the E.M.F. determinations have been thoroughly discussed and it has been pointed out from these results that except in a very few cases, not more than 40% of silver exist in the ionic condition. Or, in other words, a large percentage of silver exists in a form other than ionic, which supports our own conclusions, which have been arrived at from electric conductivity and diffusion experiments.

5. Experiments have also been undertaken to determine the electric conductivity of Lead Chromate in agar-agar solution and the results obtained have been discussed.

44. Evidence in favour of the existence of silver chloride in gelatine in the colloidal condition: electric conductivity of silver chloride in gelatine—III.

A. C. Chatterji.

1. In previous papers (Proc. Ind. Science Congress, 1926, and Trans. Faraday Soc., *72*, 23, 1926), it has been proved that silver chromate exists in the colloidal condition when formed in the presence of gelatine.

2. In this paper experiments have been undertaken to find out the electric conductivity of silver chloride of different strengths in gelatine of varying concentrations at 35°C., the silver chloride being produced by the addition of equivalent quantities of silver nitrate and potassium chloride.

3. Conductivity of equivalent concentration of silver nitrate and of potassium chloride in gelatine under identical conditions has also been determined for each set of experiment.

4. It has been found out from the above experiments that the conductivity of silver chloride is much less than what it should have been if it were in the ionic condition. In the majority of the cases investigated the conductivity of silver chloride and potassium nitrate produced along with it, is less than that of potassium nitrate alone, which means that potassium nitrate has been adsorbed by silver chloride in its course of formation, thereby lowering the active concentration of potassium nitrate.

45. The heats of neutralisation of eugenol and isoeugenol.

G. Gundu Rao.

A determination of the heats of neutralisation of these two isomers has been made, in order to study their acidic behaviour.

The heat of neutralisation of eugenol at about 25°C. when a slight excess of alkali is employed is found to be 6476 calories per mol. and 6790 calories per mol. with a large excess of alkali. Because of incomplete solution when an equivalent amount of alkali is employed and partial precipitation of the salt with a large excess the value for isoeugenol, 6550 calories per mol., is only approximate.

An attempt to determine the dissociation constants of the two compounds is being made.

46. The variation of extinction-coefficient with temperature.

B. K. Mukerji and A. K. Bhattacharji.

It has been observed by us as well as by several other authors that in many photochemical reactions the yield per quantum changes markedly with temperature even when all other conditions are kept precisely constant. There is, however, no investigation on record proving that the amount of light absorption changes with temperature. The present investigation was taken up with a view to show that the extinction coefficients of some coloured solutions for the absorption of light in the visible region vary appreciably with changes in temperature—thus explaining the frequent increase in the quantum yield with temperature.

Fifteen coloured solutions were investigated and in all cases the extinction coefficients were found to increase systematically with increase in temperature.

In all cases straight lines are obtained when extinction coefficients are plotted against temperature.

The results have been explained from the point of view of the change of hydration of the solutes at higher temperatures.

47. The preparation and properties of triglycerides of fatty acids with an even number of carbon atoms.

R. B. Joglekar and H. E. Watson, Bangalore.

A number of triglycerides have been prepared by two different methods (I) heating the acid with glycerol in molecular proportions at reduced pressure at about 200°C., (II) heating trichlorhydrin and the silver-salt of the acid in the presence of Xylol. The products obtained have identical properties after purification.

Values for the (1) Melting point, (2) Solidifying point (3) Density, (4) Viscosity, (5) Refractive index, (6) Surface tension as also the temperature coefficients in the last cases have been obtained for Stearin, Palmitin, Myristin, Laurin and Caprin. Their behaviour shows that in the liquid state they exist in one form only, and not as an equilibrium mixture of two forms.

The densities and viscosities of binary mixtures of stearin and palmitin have been determined at 8°. The curves obtained are almost straight lines.

48. Hydrolysis of gelatin.

B. N. Desai and T. R. Bolam.

The effect of hydrolysis of gelatin on its power to prevent the formation of Ag_2CrO_4 from solutions of $AgNO_3$ and K_2CrO_4 has been studied. It is found that the inhibitive power of gelatine first decrease, then increases and on further hydrolysis it again decreases.

The P_H of the gelatine solutions (as measured by the colorimetric method) is increased to a small extent by hydrolysis and shows little variation with the progress of the latter.

It is also observed that by bringing the P_H of hydrolysed gelatine to that of unhydrolysed by the addition of dilute acetic acid the inhibitive power of hydrolysed gelatine is in no way increased although the addition of the same amount of acetic acid to the unhydrolysed gelatine increases its inhibitive power a great deal.

49. Electro-motive behaviour of cupric oxide.

BASRUR SANJIVA RAO *and* N. G. CHOKANNA.

The half-cell platinum: cupric oxide, cuprous oxide, normal sodium hydroxide solution has been observed to give an inconstant potential difference by Allmand (J. C. S. 97,603, 1910) and by Maddison (Trans. Far. Soc., p. 27, 1926) no satisfactory explanation being hitherto available.

The authors of this paper have carried out measurements with cells in which the cupric oxide used had been first warmed to dryness with an alcoholic solution of sodium hydroxide and then heated at different temperatures with suitable precautions. Such heating was found to cause an ageing effect which tends to give constant potential values.

No appreciable ageing effect was noticed with cuprous oxide under similar treatment.

50. The decomposition of nitrous oxide in the silent electric discharge: The kinetics of the reaction, Part II.

SHRIDHAR SARVOTTAM JOSHI.

In an investigation of the applicability of the law of the mass action in the case of the above reaction, it was found that the effect of varying the gas pressure on (1) the fractional change during a given time interval, and (2) the time corresponding to a constant fractional change, is in a sense opposite to that to be expected from the classical equations for the chemical reactions of the various 'orders.' A quantitative explanation of this result has been found in an analysis of the electrical factors (as a function of the gas pressure), which were found to be the chief determinants of the change. An exponential relationship has been found empirically between the gas pressure, and (1) the diminution of the percentage change in the initial stages and (2) the increase of the total time for the complete reaction, in several series of results. This relationship has been deduced on the basis of a theory advanced recently (Elliot, Joshi and Lunt, Trans. Farad. Soc., 1927, 23, 57). From this theory the critical energy for the first stage and for the complete decomposition of the nitrous oxide molecule in the discharge due to an electrionic collision has been calculated to a first approximation to be 0·9 volt and 3·0 volts respectively.

51. The decomposition of nitrous oxide in the silent electric discharge: the current and the energy variations during the reaction, Part III.

SHRIDHAR SARVOTTAM JOSHI.

During the course of a previous investigation on this subject (Joshi, Trans. Farad. Soc., 1927, 23, pp. 227–238) a remarkable variation of the discharge currents was observed relating to the different stages of the above reaction. It appeared from the literature that no instance of this phenomenon has been observed; it has therefore been investigated in some detail. The value of the current in the ionisation space, and the corresponding rate of change diminish from large initial values during the first phase, become very small in the intermediate stage, and show a sudden increase towards the end of the decomposition. The duration of any given phase, the actual value of each of the quantities mentioned above, and its rate of change with time vary systematically with respect to the initial pressure for a constant applied potential. These results have been traced to the corresponding variation in the intensity of the ionisation, and of the mean electrionic velocity, due to the presence of nitrogen peroxide, which appears as an intermediate product of the

decomposition of nitrous oxide in the discharge. A mechanism of the complete reaction has been advanced from the data for the composition of the gaseous mixtures at successive times during the decompositions, started at different initial pressures.

52. The decomposition of nitrous oxide in the silent electric discharge: further investigations on the current and the energy variations during the reaction, Part IV.

SHRIDHAR SARVOTTAM JOSHI.

A confirmation of the explanation advanced in Part III of this series for the marked and the concomitant variation of the significant electrical quantities and of the reaction rate has been observed in a study of the dielectric strength, of the reaction mixture during the course of the decomposition. A study has also been made of the dielectric strength of nitrous oxide as a function of the gas pressure in different frequencies of the A. C. supply.

53. The decomposition of nitrous oxide in the silent electric discharge, Part V.

SHRIDHAR SARVOTTAM JOSHI.

The admixture of foreign gases mentioned below with a constant amount of nitrous oxide diminishes, (1) the percentage change in a given time, (2) the discharge current, (3) the energy consumed in the reaction vessel, and (4) the inverse of the dielectric strength of the gas. The effect increases by increasing the amount of the contaminant, the order being N_2 > air > O_2 > NO_2. Further the inhibition of the decomposition due to addition of N_2 and O_2 applied respectively only to the first stage of the reaction and to the complete reaction, as judged from the marked difference. The characteristic values of the ratio N_2/O_2 for the decomposition mixture in the two cases (cf. Part I, loc. cit.). Diminution of the frequency of the A. C. supply reduced the percentage change except at very small frequencies.

54. Interaction of epichlorhydrin and cyclohexene oxide with alkali and ammonium halides.

HEMENDRA KUMAR SEN, CHITTARANJAN BARAT *and* PATIT PABAN PAL, Calcutta.

When these oxides act upon alkali and ammonium halides a very interesting reaction takes place with the liberation of alkali hydroxides and ammonia. In fact this can be shown as a lecture experiment. With an excess of ammonium chloride, the velocity of reaction of epichlorhydrin and cyclohexene oxide has been determined :

Epichlorhydrin : ammonium chloride :: 1 mol : 10 mols. (0·925 gram epichlorhydrin, 5·35 gram of pure ammonium chloride and 20 c.c. of pure absolute alcohol were made up to 250 c.c. with distilled water and placed in a thermostat at 35°C. At an interval of 1 hour, 10 c.c. of the solution was taken out, at once mixed with an excess of cold water and titrated with N/100 sulphuric acid).

Time in hrs.	C. cs. of N/100 H_2SO_4 used. Expt. I.	Expt. II.	Mean titre.	Velocity constant $K=\frac{1}{t}ln\frac{a}{a-x}$
1 hour ..	2·765	3·065	2·915	0·2040
2 hours ..	4·877	4·904	4·890	0·1851
3 ,, ..	6·938	7·100	7·019	0·1960
4 ,, ..	8·848	8·787	8·817	0·2042
5 ,, ..	10·709	9·502	10·105	0·2040
....	....	....	....	....
24 ,, ..	15·86	15·734	15·797	....

Time in hrs.	C. cs. of N/100 H_2SO_4 used. Expt. I.	Expt. II.	Mean titre.	Velocity constant $K=\frac{1}{t}ln\frac{a}{a-x}$
Epichlorhydrin : Ammonium. Chloride : 1 : 50.				
1 hour ..	13·13	13·1	13·12	0·5625
2 hours ..	20·8	20·74	20·77	0·5715
3 ,, ..	24·8	24·75	24·78	0·5584
4 ,, ..	27·57	27 57	27·57	0·5865
5 ,, ..	29·39	29·48	29·44	0·6734
6 ,, ..	30·49	30·48	30 49	....
....	....	....	....	....
24 ,, ..	30·49	30·48	30·49	....

With epichlorhydrin : ammonium chloride : : 1 : 100, K=0.9523, when the volume of solution is made up as described before, i.e., made up to 250 c.c. If, however, the volume is doubled retaining the same molecular proportion between the reactants, K=0·4437; when the volume is quadrupled, K=0·2442.

55. Reactions at the surface of hot metallic filaments—Platinum, Platinum-Iridium alloys and Tungsten.

B. S. SRIKANTAN.

The nature and course of the reaction $H_2+CO_2 \rightarrow CO+H_2O$ have been studied at the surface of platinum, platinum-iridium alloys (composition :—5, 10, 15, 20, 25 and 30 per cent. iridium) and tungsten at temperatures between 1000° and 1600°C. The reaction is unimolecular in all cases. The alloys are more active than pure platinum. The alloys of composition 20, 25 and 30 per cent, iridium change their activity with use while those of 5, 10 and 15 per cent. are steady. Tungsten is more active than platinum but less so than platinum-iridium alloys. The temperature-coefficient and the apparent heats of activation have been calculated in each case from the observed velocity constants. Microscopic examination of the filaments before and after the reaction shows that the nature of the surface is greatly altered.

56. Esterification in the gaseous phase with solid catalysts.

N. G. GAJENDRAGAD.

The esterification of methyl and ethyl alcohols with acetic acid has been studied using potassium alum and silica catalysts at 230°C. The equilibrium constant has been found to be not far from that obtained by other observers in the liquid phase at lower temperatures.

57. Studies on the substituted quaternary azonium iodides, Part V. The molecular state of phenyldimethyl azonium, phenylmethylethyl azonium, phenyldiethyl azonium, phenylmethylbenzyl azonium, phenylpropylbenzyl azonium iodides in solution.

BAWA KARTAR SINGH *and* MOLA RAM SUD.

The molecular weights of five substituted quaternary azonium iodides are determined, using the Lumsden-Walker boiling-point method, in water and ethyl alcohol. The solutions employed are very dilute, the concentration, in most cases, ranging from 0·6 to 1·5 per cent. The following conclusions are drawn from this work:—

1. The molecular weights of phenyldimethyl azonium, phenylmethylethyl azonium, phenylmethylbenzyl azonium and phenylpropylbenzyl azonium iodides are lower in ethyl alcohol than in water; in the case of phenyldiethyl azonium iodide this relation is reversed. The degree of dissociation is, therefore, greater in ethyl alcohol, a solvent of low dielectric constant, than in water, a solvent which has a very high value. It is, therefore, clear that the Nernst-Thomson rule is not followed in these cases.

2. In aqueous solution, the degree of dissociation of the above mentioned substituted quaternary azonium iodides increases with increasing formula-weight of the base; but this regularity does not appear in ethyl alcohol.

3. The degree of dissociation of the salts increases with dilution in both the solvents.

4. The molecular weights furnished by the two methods, namely, the volume and the weight methods, are nearly identical for very dilute solutions.

58. Catalytic preparation of a gas rich in methane from a mixture of watergas and steam.

J. C. GHOSH *and* K. CHAKRAVARTY, Dacca.

In previous investigations, the authors have shown that a gas mixture containing CO and H_2 in 1 : 1 by volume can be made to yield a fuel gas containing over 25% methane if passed over suitable catalysts at temperatures 350°–450°C. The efficiency and life of certain catalysts have now been very considerably increased by introducing steam in suitable proportions in the reacting gas mixture. The following reaction takes place simultaneously on the catalyst surface:—

(1) $2CO \rightarrow CO_2 + C$;

(2) $C + H_2O \rightarrow CO + H_2$;

(3) $CO + 3H_2 \rightarrow CH_4 + H_2O$;

(4) $2CO + 2H_2 \rightarrow CH_4 + CO_2$.

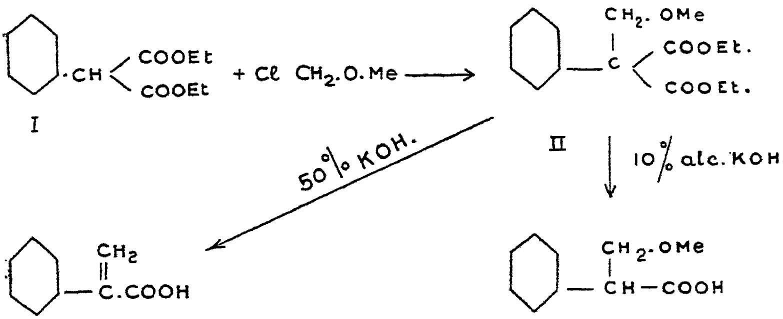
It will be seen from (1) and (2) that carbon monoxide reacts with steam giving carbon dioxide and hydrogen. The hydrogen so produced increases the ratio of H_2 to CO in the reacting gases, and prolongs the life of the catalyst by preventing deposition of carbon. Catalysts have

been found which so regulate the rates of the reactions given above, that the resulting fuel gases after removal of CO_2, contain more than 50% CH_4.

59. Condensation of mono-chlor methyl ether with phenyl malonic ester.

M. GOPALA RAO *and* J. L. SIMONSEN.

This paper is in continuation of the Monochloro methyl ether condensations carried out by Dr. J. L. Simonsen and embodies the results so far obtained in the above. This describes a simple method of synthesising atropic acid. Work is proceeding.



III atropic acid

IV methoxy Tropic acid B.P. 164–168 | 5 m.m.?

60. Studies in Michael condensation.

PRAFULLA CHANDRA MITTER *and* ASOKE CHANDRA RAY, Calcutta.

By the condensation of ethyl-sod-acetoacetate with ethyl citraconate in alcoholic solution, Michael (J. pr. Chem 1887 (2) 35 351) obtained an additive product $C_{15}H_{24}O_7$ and interpreted the reaction as follows:—

COMe . CHNa . COOEt + CMe (COOEt) : CHCOOEt

→COMe . CH (COOEt) . CMe (COOEt) . CHNa COOEt (Formula I)

An acidic product was formed at the same time which M. could not purify and left unstudied.

On repeating M's experiment under different conditions we found that the reaction had followed a different course in the case actually studied by M. The citraconic ester had under the influence of alcoholic sodium hydroxide undergone transformation into Itaconic ester (c.f. Hope T. 1912, *101*, 892), which had condensed with ethyl sod-aceto-acetate thus:—

COMe . CHNa . COOEt + CH_2 : C(COOEt) . CH_2COOEt

→COMeCH(COOEt) . CH_2 . CNa(COOEt) . CH_2COOEt (Formula II)

This was confirmed by condensing itaconic ester with acetoacetic ester in presence of "molecular" sodium in ether when an identical product was formed. A substance having formula (I) is formed when the condensation between the two reactants takes place in presence of "dry" sodium ethoxide or molecular sodium.

The products of acidic nature which always accompany these condensation products could not be isolated in the pure state but analysis of their semicarbazones show that they are di-hydroresorcinol derivatives.

Similar results were obtained with ethyl citraconate and ethyl-methyl-aceto-acetate.

In the case of condensation of fumaric ester with ethyl aceto-acetate first studied by Ruhemann and Browning (T. 1898, 73 282) or with ethyl-methyl aceto acetate there is no possibility of isomeric change and the same condensation products are obtained whether the condensing agent is sodium ethoxide in alcohol or "molecular" sodium in ether. Here also we could isolate the semicarbazones of the ring-compounds.

Condensation of ethyl citraconate with ethyl cyanacetate gave in presence of alcoholic sodium ethoxide

$CN . CH(COOEt)CH_2 . CH(COOEt) . CH_2COOEt$ and

$CN . CH(COOH)CH_2 . CH(COOEt) . CH_2COOEt$

(Vide Perkin and Thorpe T. 1899, 75, 52). With "molecular" sodium we obtained

$CN . CH(COOEt) . CMe(COOEt) . CH_2 . COOEt$

Lastly, ethyl fumarate gave with ethyl cyanacetate

$CN . CH(COOEt) . CH(COOEt) . CH_2COOEt$ and

$CN . CH(COOH) . CH(COOEt) . CH_2COOEt.$

61. Extension of Michael's reaction.

P. C. Guha *and* M. N. Chakladar.

Michael's reaction takes place between sodium derivatives of aceto-acetic ester, malonic ester and cyanacetic ester and compounds of the general formula RCH : CHX or RC : CX in which Risa positive or negative organic radical and X is a strongly negative redical like carboxyl or cyanogen. The action of the above mentioned sodium derivatives has now been studied upon mustard oils and isocyanates and the double bond existing between the nitrogen and carbon atoms opens up the possibility for the sodium atom and the rest of the molecules $[-CH(COOEt)_2$, $CH_3 . CO . CH . COOEt]$ and CN . CH . COOEt to be attached to both of its sides, thus :—

$$\begin{array}{ll} R-N:C:S & \\ \quad + & R-N-C=S \\ Na.\ CH : (COOEt)_2 & \quad\ \ | \quad\ \ | \\ & \quad Na\ \ CH(COOEt)_2 \end{array}$$

which gets easily decomposed by acids, to yield compounds of the general formula $RNH-CS-CH_3$ together with carbon dioxide and alcohol. Isocyanates react similarly to yield compounds of the general formula $RNH-CO-CH_3$.

62. Replacement of sulphonic groups by nitro-groups in aromatic halogen compounds.

P. S. Varma *and* K. A. Joshi.

It has been shown (Datta and Varma, Jour. Am. Chem. Soc. 1919, 41, 2039; Jour. In. Chem. Soc. 19127) that sulphonic groups can easily be replaced by nitro groups in aromatic phenolic and amino-compounds by means of nitrous gases. This investigation has been continued further and it has been possible to replace the sulphonic groups by nitro groups in a number of halogen derivatives of aromatic hydro-carbons.

63. Influence of substitution on the oxidation of side-chain in the benzene nucleus.

P. S. Varma *and* P. B. Panicker.

The authors have used a neutral solution of potassium permanganate

as an oxidising agent and have oxidised p-nitro-toluene, p-toluic acid, p-chloro-toluene, p-bromo-toluene, p-iodo-toluene, p-aceto-toluidine, p-methyl cresyl ether, m-toluic acid, m-nitro-toluene, m-aceto-toluidine, m-methyl cresyl ether, o-toluic acid, o-nitro-toluene, o-chloro-toluene, o-bromo-toluene, o-iodo-toluene and o-aceto-toluidine under the identical experimental conditions and have come to the conclusion that in the p-series the order (the degree of oxidation decreasing) in which the side-chain is oxidised is–COOH,–NO_2,–Br,–Cl,–OCH_3,–I,–$NHCOCH_3$, and in the o-series the order is–NO_2,–COOH,–Br,Cl,–$NHCOCH_3$, and–I. Regarding position isomers, there does not seem to be any regularity. p-Nitro-toluene is oxidised most, the m-body the least whereas in the aceto-toluidines, o-derivative comes first and the p-derivative last.

64. Nitration of benzene.

P. S. Varma *and* K. A. Joshi.

Benzene has been nitrated by means of nitric acid alone in presence of zinc, copper, tin, and antimony as catalysts. It has been possible to get some increase in the yield of nitro-benzene in presence of metallic tin, but the yield so obtained can in no way be compared with the yield obtained by using a mixture of nitric and sulphuric acid as is done in the ordinary nitration.

65. Studies in the anthracene series. Halogenation and nitration (Preliminary).

P. S. Varma *and* A. Subramanyam.

Mono-iodo and di-iodo-anthraquinone (the latter for the first time) have been obtained by the action of sodium nitrite and fuming sulphuric acid on anthracene and iodine. A number of bromo-compounds have also been obtained by the action of bromine and fuming sulphuric acid. Some of these halogenated compounds have also been nitrated. In some cases nitro-derivatives have been obtained whilst in others the halogen compounds are decomposed and the halogens liberated.

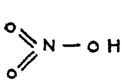
66. Nitration by means of a mixture of nitro-sulphonic and fuming nitric acids. Part II.

P. S. Varma *and* S. K. Sharma.

This is in continuation of the work by Varma and Kulkarni (Jour. Am. Chem. Soc. 1925, 47, 143.) Sulphanilic acid, α-nitro-naphthalene, o-amino-benzoic acid, m-amino-benzoic acid, p-amino-benzoic acid, amino-aceto-phenone, naphthylamine-sulphonic acids have been tried and a number of nitrated products obtained from them.

67. The influence of water and sulphuric acid in the nitration of hydrocarbons, Part I.

D. D. Karve *and* A. B. Kumthekar.

The investigation has been undertaken with a view to find out which of the two forms of nitric acid, the pseudo form  or the acid

form $N \begin{matrix} \diagup O \\ -O \\ \diagdown O \end{matrix} \Big\} H$ or the dissociated acid $H^{\cdot} + \left\{ N \begin{matrix} \diagup O \\ -O \\ \diagdown O \end{matrix} \right\}'$ was responsible for the nitration of hydrocarbons.

The work of Schäfer and of Hantzsch has shown that nitric acid has absorption spectra either resembling its salts or resembling its esters depending upon the solvent and also upon the concentration.

Nitration of benzene, toluene, the xylenes as also of some heterocyclic compounds was undertaken, using definite quantities of the substances with varying quantities of nitric acid in different dilutions and also of varying proportions of nitric acid and sulphuric acid and the extent of nitration estimated by means of the estimation of the NO_2 group.

On account of the mutual solubility of nitric acid and the nitro-compound, the measurement of the yield of the compound was rendered rather difficult and special methods of procedure had to be employed. (cf. Spindler Ann. 224.)

The results obtained up to now seem to indicate that the acid with the formula seems to be responsible for the nitrations. The work is still in progress.

68. Dyes derived from oxalyldibenzylketone.

S. A. Saletore *and* Gopal Chandra Chakravarti.

Several investigators have so far found that the hydroxyiminazoles obtained by condensing phenanthraquinone and acenapthaquinone with salicylaldehyde in presence of ammonia are all colourless crystalline compounds (Japp. and Streatfield. J. C. S. 1882, *41*, 146. and others), but those derived from substituted salicylaldehydes are coloured (Sircar and Sircar. J. C. S. 1923, *123*, 1559.) It was therefore anticipated that the iminazole from oxalyldibenzylketone and salicylaldehyde would likewise be colourless; whereas this compound was obtained as a deep brown coloured crystalline product with marked chromophoric properties. This is evidence in support of the observation made by one of us recently (Chakravarti J. I. C. S. 1925, *2*, 71) that oxalyldibenzylketone is a much better chromophore than phenanthraquinone or acenapthaquinone although the latter bodies contain condensed benzene nuclei. Several other iminazoles derived from oxalyldibenzylketone on the one hand and vanillin, nitrosalicylaldehyde, *p*-and *m*-hydroxybenzaldehydes, resorcylaldehyde, bromosalicylaldehyde, etc., on the other, are also found to be deeply coloured.

69. Diazotisation of difficultly diazotisable amines.

S. Krishna *and* Ratan Lal Bhatia.

The usual methods of diazotisation are not workable in the case of certain substituted amines; nor are such treatments as pressure, high temperature, concentration, solvents, etc., applicable in all cases. Realising this difficulty, a method has been worked out in which the use of a basic solvent like pyridine has been made. The procedure employed is to make a solution of the desired amine in minimum quantity of pyridine and adding to it a strong solution of sodium nitrite (calc. quantity) in water. This mixture is then added to a dilute solution of HCl very slowly in small quantities, when it is found that diazotisation proceeds satisfactorily. In this way tribromaniline, 2 : 6 dichloro-p-nitraniline, dibromo-p-aminobenzoic acid and dibromo-p-aminobenzaldehyde have been successfully diazotised.

70. Synthesis of straight chain unsaturated acids.

R. Bhattacharya *and* J. L. Simonsen.

It has been recently suggested that iso-erucic acid is an inseparable mixture of two unsaturated acids which may be synthesised from (*a*) octinine and 14-iodo tetradecan acid, and (*b*) undecinin and 10-brom-undecylic acid. As a preliminary to their preparation the synthesis of homologous acids has been tried. 12-iodo-dodecan acid has been prepared, in the following way, and condensed with the sodium compound of decinin to get behenolic acid.

Castor oil→Undecylenic acid→10-Bromundecylic Me-estor→cyano undecylic Me-ester→decamethylene dicarboxylic Me-ester

Potassium salt of the half hydrolysed ester→12-hydroxy Lauric acid →12 Iodo-Lauric acid.

Decinin was prepared by the action of mono sodium acetylide on octyl iodide.

71. Synthetical experiments in the flavone series—Part I a synthesis of 7 : 8-dihydroxy-2-methylchromone and of 7 : 8-dihydroxyflavone.

K. Venkataraman.

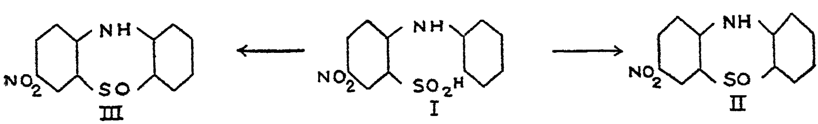
The method of Allan and Robinson for the synthesis of flavonols is now being extended to the preparation of flavones and flavonols containing hydroxyls in 7 : 8-positions. Thus, by the condensation of gallaceto-phenone with acetic anhydride and sodium acetate and hydrolysis of the product, 7 : 8-dihydroxy-2-methylchromone has been prepared; and 7 : 8-dihydroxyflavone by the interaction of gallacetophenone, benzoic anhydride and sodium benzoate. The reactions and dyeing properties of these substances are described.

The synthesis of other hydroxyflavones derived from gallaceto-phenone and ω-methoxygallacetophenone is in progress. The latter compound, to which no reference is found in the literature, is being prepared by the action of methoxyacetic acid on pyrogallol in presence of zinc chloride.

72. Synthesis of substituted thiazines.

S. Krishna *and* Mitter Sain Jain.

Literature on substituted thiazines shows that the methods of preparation hitherto described give only the symmetrically disubstituted derivatives and are applicable only in a very limited number of cases. An attempt is now being made to synthesise mono, di- or polysubstituted thiazines by a method that should be applicable to benzene derivatives containing acid or basic substituents. The present communication describes the synthesis of thiazine by a method which utilises the reactivity of the halogen atom in negatively substituted chlorobenzene. 6, chloro—3—nitrobenzene sulphinic acid condenses with anilines, 4 nitro—2 sulphino-diphenylamine (I) being formed.



This is readily soluble in sulphuric acid. If the blue solution obtained is immediately diluted with water, the sulphoxide (II) will be precipitated, but if the solution is kept for half an hour before dilution, 3—nitrothiazine (III) will be obtained and sulphur dioxide evolved.

3-nitrothiazine is readily reduced to 3-aminothiazine from which through the diazo-compound thiazine is obtained.

A blue colour is produced when a solution of 3-nitrothiazine in acetic acid is treated with hydrogen chloride. The production of this blue colour has been regarded as evidence of the existence of quinonoid dithionium salts. Attempts have been made to isolate such salts but these have not been successful due probably to the influence of a nitro group.

The present work is interesting because the starting material contains a nitro-group, the presence of which in the molecule has been found to inhibit the course of other methods of synthesis.

73. On the constitution of some dinitro-m-Cresols.

S. M. SANE *and* S. S. JOSHI, Lucknow.

There are contradictory statements regarding the constitutions of dinitro-m-cresols. Gibbs and Robertson have described two dinitro-m-cresols. (1) 1-methyl 3-hydroxy-2 : 6-dinitrobenzene (m p. 74°C.) and (2) 1-methyl 3-hydroxy 4 : 6-dinitrobenzene (m.p. 60°C.). Will prepared from one of the trinitrotoluenes 1-methyl 3-hydroxy 4 : 6-dinitrobenzene (m.p. 74°C.), while Borsche prepared 1-methyl 3-hydroxy 4 : 6-dinitrobenzene (m.p. 63–65°C.) from 3 chloro 4 : 6-dinitrotoluene. According to these statements there are thus two dinitro-m-cresols which have the same constitution but different melting points and two dinitrocresols having different constitutions have the same melting points.

Investigation has shown that Borsche's 1-methyl 3-hydroxy 4 : 6-dinitrobenzene has the m.p. 74°C. Its constitution has been further confirmed by the fact that this dinitro-m-cresol and 3-chloro 4 : 6-dinitrotoluene from which it is prepared, yield the same dinitrotoluidine. Gibb's and Robertson's dinitro-m-cresol of m.p. 74°C. is therefore 1-methyl 3-hydroxy 4 : 6-dinitrobenzene and the bromo derivative which they and Kehrmann prepare has the constitution 1-methyl 2-Bromo 3-hydroxy 4 : 6-dinitrobenzene. The 1-methyl 2-bromo 3-chloro 4 : 6-dinitrobenzene prepared from the last compound is identical with the chlorobromodinitrotoluene prepared by Cohen and Smithels.

74. Camphor as a preservative for tan-liquors.

P. D. DALVI.

Aspergillus niger and certain other fungi are constantly found in tan liquors and bring about a reduction in the tanning value of the liquors owing to the fermentation of the tannic acid induced by the organism. The action of various disinfectants or preservatives in diminishing this loss has been investigated and of these tried camphor seems the most promising, being efficient in small quantities and without harmful effect on the activity of the liquor.

75. Lengthened ortho-di-derivatives of benzene and their ring-closure : Part I.

P. C. GUHA *and* T. N. GHOSH.

Ortho-nitrophenyl-4-arylthiosemicarbazides on reduction with tin and hydrochloric acid yield simultaneously (*a*) 1-o-aminophenyl-4-arylthiosemicarbazides $C_6H_4(NH_2)$. NH . NH . CS . NHR and (*b*) 1-N-R-2 : 3-benzo-6-thiol-1 : 4 : 5-triazines. Compounds of type (*a*) can be converted into compounds of type (*b*) on treatment with acetic anhydride and strong hydrochloric acid showing conclusively that in the reduction process the formation of (*a*) precedes that of (*b*). The reactive amino-group of compounds of type (*a*) has been utilised by allowing it to react with carbimides and thiocarbimides, potassium cyanate and thiocyanate and

aldehydes when the following types of lengthened ortho-di-derivatives of benzene (viz. R'NHCO . NH . C_6H_4 . NH . NH . CS . NHPh, R'NH . CS . NH . C_6H_4-NH . NH . CS . NHPh and RCH : N-C_6H_4-NH . NH . CS . NHPh where R_0-Ph, tolyl, xylyl, allyl, or H) are obtained and they have been made to yield various types of ring-closed compounds, viz. benzo-thio-octa-triazines and benzo-octa-tetrazines. Compounds of type (*a*) give benzo-thio-hepta-triazines and benzo-hepta-tetrazines respectively on treatment with ferric chloride and hydrazine hydrate.

76. Lengthened ortho-di-derivatives of benzene and their ring-closure : Part II.

P. C. GUHA *and* T. N. GHOSH.

Ortho-nitrophenylsemicarbazides on reduction, yield simultaneously (*a*) ortho-amino-phenyl-semicarbazides and (*b*) benzo-triazines. Compounds of type (*a*), by virtue of the amino group present in it, react with carbimides, thiocarbimides, aldehydes, ferric chloride, hydrazine hydrate, etc., to yield 1-carbamido-2-semicarbazid-o-benzene, 1-thiocarbamido-2-semicarbazido-benzene, 1-o-benzal-anilino-semicarbazides, 3 : 4-benzo-7-R-amino-1 : 2 : 5 : 6-oxheptatriazines and 1-N-R-3 : 4-benzo-7-hydroxy-1 : 2 : 5 : 6-hepta-tetrazines. The nitro-hydrazine reacts with potassium cyanate, potassium thiocyanate, o-chlorbenzaldehyde, glyoxal, CS_2 KOH MeI, $COCl_2$, Cl . COOEt to yield o-nitrophenyl-semi-carbazide, o-nitrophenyl-thiosemicarbazide, chlorbenzaldehyde-o-nitrophenylhydrazone, glyoxal-o-nitrophenyl-osazone, o-nitrophenyl-methyl-dithiocarbazinate, di-o-nitrophenyl-carbohydrazide and o-nitrophenyl-ethyl-carbazinate and they have been found to form 5 or 6 or 7 or 8 or 10-membered heterocyclic compounds, as the case may be on reduction.

77. Hetero-ring formations with 1-substituted thiocarbohydrazides : Part I.

P. C. GUHA *and* S. K. RAY CHOUDHURY.

Due to the presence of two hydrazine groupings, thiocarbohydrazide reacts with various organic substances : (Guha and De, Soc., 1924, *125*, 1215 ; J. Indian C. S., 1924, *1*, 141 ; 1925, *2*, 225). It was expected that if one of these two hydrazino groups be substituted the behaviour of the resulting carbohydrazides would be different from that of the unsubstituted product. With this object in view a number of mono-aryl-substituted-thiocarbohydrazides (of which not a single member is known up to this time) have been prepared by the action of hydrazine hydrate upon aryl-dithiocarbazinates and they have been found to form oxdiazines with ortho-diketones, oxheptatriazines with monoximes of 1 : 2-diketones, pyrazoline derivatives with -ketonic esters, thio-octa-diazines with 1 : 4-diketones, thiodiazines with halogenated ketones and esters. The aldehyde-aryl-thiocarbohydrazones give 2-phenylhydrazino-5-R-1 : 3 : 4-thiodiazoles by the oxidising action of ferric chloride and 2-aldehydehydrazones of 2 : 5-diketo-4-aryl-tetrahydro-1 : 3 : 4-thiodiazines with halogenated ketones and esters.

78. Hetero-ring formations with substituted thiocarbohydrazides : Part II.

P. C. GUHA *and* S. K. RAY CHOUDHURY.

In this part, the action of formic acid, acid chlorides and anhydrides, carbimides and thiocarbimides have been studied. 2-Anilinomino-1 : 3 : 4-thiodiazole and 2-anilinamino-5-thiol-1 : 3 : 4-thiodiazole are obtained from formic acid and potassium ethyl xanthate ; thionyl, malonyl and phthalyl chlorides yield 2-anilinamino-5-oxy-5 : 1 : 3 : 4-dithiodiazole ;

2-anilinamino-5 : 7-diketo-1 : 3-4-thioheptadiazine and 2-anilinamino-5 : 8-diketo-6 : 7-benzo-1 : 3-4-thio-octadiazine respectively. The action of chlorides of dibasic acids upon aldehyde-aryl-thiocarbohydrazones and the action of different ring-closing agents (e.g. HCl, NaOH, $FeCl_3$, etc.) upon the mustard oil and isocyanate derivatives have been found to yield different types of thiobiazole and triazole derivatives.

79. Study in the condensation of compounds with conjugated double bonds with reactive methylene groups.

CHITTARANJAN BARAT, Calcutta.

The condensation between compounds like Benzalacetone, with one like Cyanoacetamide, was first observed by Sen (J.C.S., Trans., *107*, 1366) who, did not, however, study the mechanism of the reaction. The present work was undertaken with a view to do that, as well as to compare the effects of different condensing agents, e.g. Sodium Ethoxide (Michael), Piperidine (Knoevenagel), Ammonia, etc. Cyanoacetamide has been made to condense with (1) Benzalacetone, (2) α-Benzalmethylethyl ketone, (3) Benzalacetophenone, and (4) Benzal-p-Methylacetophenone, under all the different conditions mentioned above. The reactions appear to take place in the following stages :—

$$\begin{array}{c} Ph\,.\,CH{=}CH\,.\,CO\,.\,R \\ + \\ CN\,.\,CH_2\,.\,CO\,.\,NH_2 \end{array} \rightarrow \begin{array}{l} Ph\,.\,CH\,.\,CH_2\,.\,CO\,.\,R \\ \quad\;\;| \\ CN\,.\,CH\,.\,CO\,.\,NH_2 \end{array}$$

$$\begin{array}{l} Ph\,.\,CH\,.\,CH_2\,.\,C(OH)\,.\,R \\ \quad\;\;| \qquad\qquad\;\; | \\ CN\,.\,CH\,.\,CO\,.\,NH \end{array} \qquad \begin{array}{l} Ph\,.\,CH\,.\,CH_2\,.\,C\,.\,R \\ \quad\;\;| \qquad\quad\;\; \| \\ CN\,.\,CH\,.\,CO\,.\,N \end{array}$$

all of which upon hydrolysis finally yield the Pyridine derivative :—

$$\begin{array}{l} Ph\,.\,CH{-}CH_2{-}C\,.\,R \\ \quad\;\;| \qquad\qquad \| \\ \quad CH_2{-}CO{-}N \end{array} \quad ;\ R \text{ being } CH_3,\ C_2H_5,\ C_6H_5, \text{ and } C_6H_4\,.\,CH_3$$

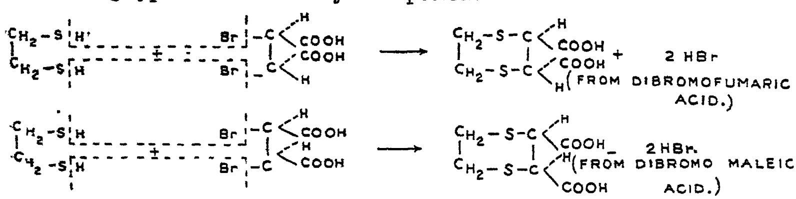
respectively.

Attempts have also been made to condense Benzalacetone with Phenylacetamide, Chloroacetamide, ω-Cyanoacetophenone, etc., but with only a partial success. Further experiments with other compounds having a reactive methylene group, e.g. Nitroacetamide, Acetoacetamide, Bromo- and Iodo-acetamides, Cyanoacetone, and β-diketones have also been undertaken.

80. Cis-trans isomerism in closed ring compounds having two sulphur atoms in the nucleus.

CHITTARANJAN BARAT, Calcutta.

Dibromo succinic acid occurs in two different isomeric forms according as it is obtained by brominating Fumaric or Maleic acids. The assumption therefore, that they still retain their steric characteristics, is justifiable. If now they are made to condense (after protecting the carboxyl groups, in the form of a salt or an ester,) with Ethylene Mercaptan, the following types of reaction may be expected :—

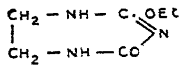


The condensations have actually been effected in the presence of Sodium Ethoxide, in alcoholic suspension, (the mercaptan working best as an alkali mercaptide). The products of condensation, though different, have not yet been obtained in a sufficiently pure form.

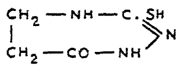
81. Cis-trans-isomerism in ethyl-carbethoxy—thiocarbamate. Synthesis of four-, five-, six- and seven membered heterocyclic compounds from ethyl-carbethoxy-thiocabamate.

P. C. Guha *and* N. C. Dutt.

Ethyl-carbethoxy-thiocarbamate has been isolated in two isomeric forms, one melting at 44°C and the other at 144°C., and the latter has been found to be convertible into the former by boiling with water containing a drop of hydrochloric acid. With ethylene diamine the lower melting variety gives a compound of the following folmula:



it is insoluble in alkali, whereas the higher melting variety gives a compound of the following formula:



it is soluble in alkali.

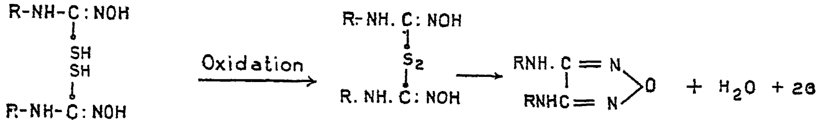
Ethyl-carbethoxy-thiocarbamate has been made to react with aromatic amines, hydrazine, phenylhydrazine, urea, phenylurea, thiourea semicarbazides, ditamines, and ortho-phenylene diamine and thus a large number of interesting hetero-cyclic cyclic compounds have been obtained.

82. Action of hydroxylamine upon mustard oils: formation of—dianilido-furo-(a: a')-diazoles.

P. C. Guha *and* M. N. Chakladar.

Hydroxylamine reacts with mustard oils to yield unstable intermediate hydroxy-thiocarbamides thus.—

R-N: C:S NH-OH RNH. CS. HNHOH, two molecules of which get easily decomposed even at the ordinary temperature to yield furo-(a : a 1)-diazoles with the separation of sulphur and water thus:—



83. The union of benzoylacetonitrile with organic bases in the presence of salicylaldehyde. Part II.

Panchapakesa Krishnamurti.

Aniline, p-Toluidine and 1 : 3 : 4 Xylidine react in a way similar to piperidine (J.C.S. 1927–*128*–1349) with benzoylacetonitrile. Improved yields were obtained by using a few drops of piperidine in the above-mentioned reactions. Ortho- and meta-Toluidines, as well as mono-methyl

aniline, p-brom aniline and methyl anthranilate were unreactive. This behaviour seems to be similar to that recently observed with nitro styrene (Worrall, J.A.C.S., 1927-*49*-1598). The aniline and p-Toluidine compounds readily yield mono-hydrochlorides, diacyl derivatives, and brightly-coloured iso-nitroso derivatives. The latter, on benzoylation, give only the benzoyl derivatives of the primary amines. The constitution of the aniline compound could be represented by

$$\text{(I) } CH_2 . Bz . \dot{C} : NH . NH . Ph . \text{ or (II) } CH_2 . B_2 . \underset{\ddot{N}H}{C} . NH . Ph.$$

84. Colour of complex diazoles.—Part III. Double quinonoid structure—the real chromophore.

GOPAL CHANDRA CHAKRAVARTI.

All attempts to correlate colour with the constitution of compounds containing fused pyrrol-iminazole or pyridine-iminazole ring systems have so far been unsuccessful. Hewitt's rule and its modification by Watson and his co-workers are not sufficiently elastic to explain the colour of these nitrogenous bodies. But when the theory of quinonoid structure is extended to heterocyclic compounds like pyrrol and pyridine, a ready explanation of the cause of colour in these condensed systems is at once available. It is found that all the known coloured condensed pyrrol-iminazole or pyridine-iminazole derivatives may be represented as having a double quinonoid pyrrol or pyridine nucleus in them whereas the colourless bodies either do not possess this structure, or if they do possess it, their chromophoric effect is neutralised by the presence of other hypsochromic groups. Hence it is suggested that the presence of a double quinonoid pyrrol or pyridine ring is necessary so that systems containing fused pyrrol or pyridine-iminazole skeletons may develop visible colour.

85. On the interaction of sulphuric acid and bromine on ethylbenzylidenediacetoacetate.

B. M. GUPTA *and* S. C. ROY, Lucknow.

With a view to obtain α-bromo derivatives of variously substituted ethyl glutarate, ethyl benzylidenediacetoacetate was treated with concentrated sulphuric acid and bromine. A crystalline compound melting at 159°C. having the empirical formula $C_{17}H_{19}O_6Br$ was obtained. By studying the products of hydrolysis and oxidation, the constitution of the compound has been fixed as Ethyl $\alpha\alpha'$-diaceto-α-bromo-β-phenyl-glutaric acid ester. This formula has been further confirmed by the study of the product of its interaction with aniline, which is a crystalline compound having the empirical formula $C_{22}H_{25}O_4N$ and melting at 131°C.

86. Preparation of P. chloraniline.

K. HABIB HASAN, Hyderabad (Deccan).

Chattaway and Orton (1901) described a method of chlorinating acetanilide by bleaching powder in glacial acetic acid. A good yield of O. and P. compounds is obtained. On hydrolysis of the anilides the yields claimed for both anilines are not obtained nor the method of separating P. chloraniline is suitable. The causes of this loss had been the subject of this paper which will be described.

87. Wandering of groups during brominations.

M. G. SRINIVAS RAO, C. SRIKANTIA *and* M. SESHA IYENGAR, Bangalore.

Work continued—(*vide* Reports, Science Congress, 1926—page—147).

with 5-nitro 4-methoxy B-resorcylic aldehyde, which on monobromination yields a normal brom-nitro-aldehyde; but this on further bromination apparently rearranges to give a dibrom-nitro derivative, in which the aldehyde is absent. The second phenolic group in the last was ethylated and the product thus obtained was found to be identical with,

(1) the nitro derivative of tri-brom resorcinol, in which both the phenolic groups had alternatively been alkylated with methyl and ethyl iodides respectively, and

(2) the dibrom (ethylated) derivative of 4-nitro resorcinol 3-methyl ether, in which the nitro-group is in the same position as in the original nitro-aldehyde mentioned first.

From these and a few other experiments the authors are led to conclude that the nitroxyl group has wandered during bromination. Work on similar and allied compounds is under way in order to gather more evidence in favour of this conclusion, since such wandering of nitroxyl is not common.

88. Para-aminophenylstibinic acid and its amine salts.

SUDHIR CHANDRA NIYOGY, Calcutta.

The complex nature of Phenyl Stibinic acid and its derivatives has been held by Schmidt (Ber. *55*, (1922) 697) while Macallum (J. Ind. Chem. Soc. *42*, (1923) 468 T.) maintains from molecular weight determinations that they are simple molecules. The former view seems to be correct from the facts:—

(1) They lose all, excepting one molecule of water, when kept in vacuo over Sulphuric acid, showing that only one molecule of water is present as water of constitution, and are therefore of the type $\{(3C_6H_5 . SbO_2)H_2O\}2H_2O$, or $\{(3C_6H_5 . SbO_2)H_2O\}3H_2O$.

(2) They dissolve completely in $\frac{1}{3}$rd their equivalent of alkali giving a solution neutral to litmus, which, however, turns acid on keeping, and takes up the full requisite amount of alkali gradually, yielding a neutral solution which remains so even on keeping or heating.

Hence it is concluded that these compounds, instead of being formed by the replacement of one of the hydroxyl groups of o-Antimonic Acid by Aryl radicals, are produced by a complex association of 3 molecules of Aryl stibinic acid, which gradually breaks up into individual molecules with KOH or NaOH, while LiOH gives the product 2Ar. Sbo, with varying amounts of water. With a view to settle the question of the constitution of the Aryl stibinic acids, amine salts were prepared by adding the requisite amount of the corresponding amine to an aquaeous suspension of p-amino stibinic acid, which dissolves readily (in a few cases by slight warming) filtering, and precipitating the salt with alcohol. The following salts with p-aminostibinic acid have been prepared: Methylamine, Dimethylamine, Trimethylamine, Ethylamine, Diethylamine, Triethylamine, Propylamine, Isobutylamine, Iso-amylamine, Benzylamine and Phenyl-ethylamine. Analytical data obtained show that they contain 3 molecules of Aryl stibinic acid and one molecule of the base which corroborates the view held by Schmidt (loc. cit). The physiological actions of these compounds are now being investigated.

89. The essential oil from the flower-heads of *Cymbopogon coloratus* Stapf.

P. PARAMESWARAM PILLAI.

The essential oil from the flower-heads of *Cymbopogon coloratus* Stapf has been described and is shown to contain *l*-camphene (app. 15 per

cent.) *l*-limonene (5 per cent.) *l*-borneel (8 per cent.) geraniol (10 per cent.) camphor, a mixture of sesquiterpenes one of which gives a nitrosate (m.p. 154°C.) and a nitrosochloride (m.p. 171°C.) and is probably α-caryophyllene.

90. Jute-seed oil.

NIRMAL KUMAR SEN.

The brown seeds of *Corchorus capsularies* yield 14·73% of oil by extraction with petroleum ether. The refined oil show a sapon. value 184·4, Iodine value (Hubl's) 102·6, acetyl value 27·3, acid value 1·5, Reichert Meissel value 0. 16, Hehner's value 94·1, Glycerol 8·12% unsaponifiable matter 2.77%. The mixed fatty acids (free from unsaponifiable matter) of the oil are a white solid mass; has the following properties: m. p. 31·5-32°C., Titre 29·9° Iodine value 113·44, neutralisation value 200·2, mean mol. wt. 280·2, and contain 20% solid and 80% liquid acids (Twitchell). The liquid acids give no ether-insoluble compound by bromination and are composed of 70·02% Oleic and 29·98% Linolic acids and yield di and tetrahydroxystearic acids respectively by oxidation with alkaline permanganate. The solid acids melt at 50–52°C. and yield "Crude Archidic acids" melting at 74-75°C. The unsaponifiable matter contains phytosterol. When purified the oil is suitable as a food and is also satisfactory for burning purposes.

91. Properties and composition of sandal seed oil.

M. SREENIVASAYA *and* N. NARAYANA.

Sandal seeds contain 50–55 per cent. of a thick viscous oil. On exposure to light, the oil spontaneously thickens to a resinous mass; at 130°–140°C. sulphur is absorbed resulting in a plastic rubber-like compound. On saponification with alcoholic potash a white resinous mass is thrown out which has very high iodine value. An ether extracted oil has the following physical and chemical constants:—

Refractive index at 60°C. 1·4790; Specific Gravity, at 30°C. 0·9304; iodine value 130–140; Sap. Value 185–195; acid value 20–25; Hehner number 96-97; Richert-Meissel value 1·5; Polensky number 0·2–0·3; Mean mol. weight of the mixed fatty acids 288·5.

92. Indian Cubeb oil.

V. P. SHINTRE.

The fruits grown in the Mysore Province gave on distillation with steam 7·5 per cent. of an essential oil. The oil has been found to contain *d*-sabinene (28 per cent.) *d*-terpinine and cineol (15 per cent), *d*-terpinenol-4, *d*-terpineol, an unidentified primary alcohol, l-cadinene and another sesquiterpene. Another sample of oil was found to contain *dl*-sabinene and the other constituents were the same as in the first sample described.

93. The constituents of *Sweertia chirata.*

A. JANAKI RAM.

Sweertia chirata, the well known valuable indian medicinal plant has been partially examined by Sahiar in 1914 and Subramaniam in 1924. A more extensive investigation of the same has now been undertaken.

By steam distillation of the alcoholic extract, a crystalline acid, a phenol and isoamyl alcohol have been obtained.

The residual resin insoluble in water has yielded an acid M.P. 312°C. and a neutral body M.P. 133°C.

(The non-volatile portion soluble in water contains an acid M.P. 193°C.)

94. Thevetin: a crystalline glucoside from the seeds of *Thevetia neriifolia*. Part I.

P. RAMASWAMI AYYAR.

The defatted seed-kernels of the yellow oleander yield to alcohol about 1·5 per cent. of a glucoside which has been obtained in the form of glistening white plates melting at 215° after softening at 190°.

Analysis gave the following values: *C*, 56·2; *H*, 7·2; *O*, 36·6 hydroxyl 2—4, methoxyl 3·0. $[\alpha]_D^{31°} = -39·2$.

Hydrolysis with 1 per cent. sulphuric acid gave 57 per cent. of sugar, and 48 per cent. of Non-sugar.

$[\alpha]_D^{31°}$ for the sugar was $+22·7°$; and an osazone was obtained melting at 205° and a pentacetate melting at 180°.

From the non-sugar, an acid was obtained melting at 150° and having an equivalent of 425.

95. On lignoceric acid from the seeds of *Adenanthera pavonina*. Part I.

P. RAMASWAMI AYYAR.

So far the main sources of lignoceric acid in nature have been beechwood tar, and peanut oil. It has been found that the above seeds yield 14% of a fixed oil equivalent to 13% of mixed acids. From the latter pure lignoceric acid $C_{24}H_{48}O_2$ melting at 80-81°C. has been prepared with a yield of 1·5 per cent. on the seeds.

The acid on bromination by Volhard's method yields a bromo-acid melting at 70-71°C. whose bromine content and equivalent weight correspond to the formula $C_{24}H_{47}BrO_2$ and the lignoceric acid thus appears identical with the acid previously obtained from other sources. The constitution is being investigated.

96. On Rubiadin.

PRAFULLA CHANDRA MITTER, MONMOHAN SEN, PRAFULLA KUMAR PAUL *and* PRIYALAL GUPTA, Calcutta.

In the Bombay Session of this Congress (1926) one of us (M) drew the attention of the Congress to the fact that the product of condensation of cresorsellenic acid with benzoic acid which was supposed, in an earlier communication to the Congress, to be Rubiadin, melts on repeated crystallisation at 265°-266°C. and therefore it could not be Rubiadin. Unfortunately the mistake in the earlier communication has been allowed to continue in the proceedings.

It has now been found that the 1-methyl-2-4-dihydroxy-anthraquinone gives a diacetyl derivative M. P. 181°-182°C. which on de-acetylation melts at 265°-266°C., so that there cannot be any doubt that Rubiadin is not 1-methyl-2-4-dihydroxy anthraquinone. Recently Stauder and Adams (J. Amer. Chem. Soc. 1927. pp. 2043) have come to the same conclusion. The 1-methyl-2-4-dihydroxy-anthraquinone prepared by them melts at 251°C. and the acetyl derivative (which they have not analysed) melts at 176°C. Evidently S. and A. had a very impure product in their hands due no doubt to the large number of stages involved in their synthesis.

We have also succeeded in synthesising Rubiadin itself by condensing 2-6-dhydroxy-p-toluic acid with benzoic acid (Schunck and Marchlewskis' original method: T, 1894, 65, 182). The 3-methyl-2-4-dihydroxy anthraquinone melts at 290°C. and its acetyl derivative melts at 225°C.

The oxy-methyl-anthraquinones present in nature have hitherto been regarded as derivatives of either α-or β-methyl anthracene. It now seems

as if there is no α-methyl anthracene derivative among the natural products for within the last few years substances like chrysorobin, chrysophanic acid, Rhein and Emodin which at one time had been regarded as α-methyl anthracene derivatives have been proved to be β-methyl anthracene derivatives. Rubiadin is here proved to be a β-methyl anthracene derivative.

One of us (M) is now engaged with Asoke Kumar Sen in the synthesis of Munjisthin which probably bears the same relation to rubiadin as Rhein to chrysophanic acid.

97. Curcumene.

B. SANJIVARAO.

This hydrocarbon, occurring in the essential oil from the rhizome of *Curcuma aromatica* Salisb. and characterised by a trihydrochloride (m.p. 84-85°C. and a nitrosate (m.p. 100-101°C.), has been found to be a mixture of two sesquiterpenes which have been separated and the names α and β-curcumene proposed. *la* curcumene is characterised by the nitrosate (m. p. 100-101°C). and has been obtained by a series of reactions from the nitrosate and has the following constants :—

$$(d^{30}_{30}=0\cdot8633;\ n^{30}_{D}=1\cdot4944;\ [\alpha]_{D}=-35\cdot4°\ [R_{L}]\ D=68\cdot86\cdot124-126/_{10\ mm}$$

Its molecular refraction shows it to be a monocyclic sesquiterpene. It takes up only two atoms of bromine and gives a liquid monohydrochloride and does not give a naphthalene derivative on treatment with sulphur.

lβ-curcumene is obtained from the solid trihydrochloride and gives a liquid hexabromide and an excellent yield of the solid trihydrochloride.

$$(d^{30}_{30}=0\cdot8625;\ n^{30}_{D}=1\cdot4888;\ [\alpha]_{D}=-37\cdot5°\ [R_{L}]_{D}=68\cdot23).$$

Some experiments with these sesquiterpenes have been described.

98. Delignification of jute fibre.

JOGENDRA KUMAR CHOWDHURY *and* RAMENDRA KUMAR DAS, Dacca.

The object of the following work is to remove incrusting matter of jute with least possible injury to the structure of the fibres.

The usual methods of removing lignone complex from lignocelluloses reduce jute to ultimate fibres or cells and also attack more or less the cellulose complex. In creosote, however, a solvent has been found which dissolves lignone matter without similarly affecting cellulose. Owing to the acidic nature of creosote, the fibre however becomes brittle, the cellulose being evidently reduced to hydrocellulose. This adverse effect has been overcome by the addition of basic substances such as pyridine. A sample of raw jute whose lignone and pentosan contents were 19·69% and 11·0% respectively, when treated with creosote mixed with 10% pyridine under optimum conditions of temp. and pr. yielded a fibre which was of apparently good tensile strength and whose lignone and pentosan contents were only 4·4% and 8·67% respectively. On treatment with alkali, the lignone and pentosan contents were further reduced to 2.5% and 409% respectively. The fibre thus obtained gives all the characteristic microscopic colour reactions of cellulose and has fairly good tensile strength.

Incidentally, the theory of Wislicenus, that in lignocelluloses,

cellulose and lignone complexes are held together by forcees of surface energy, is supported.

99. *Excoecaria agallocha* as a source of power alcohol.

HEMENDRA KUMAR SEN, SINDHU BHUSAN GHOSH *and* PATIT PABAN PAL, Calcutta.

In continuation of our search for a suitable material for the production of power alcohol, we were led to the investigation of the sawdust from a particular variety of wood, *Excoecaria agallocha,* which grows abundantly in Sundarban tracts and is now being used plentifully for the match industry and also for making cheap packing cases. Whilst with most species examined before, 22·24% of reducing sugar was found to be the maximum production after hydrolysis by Simonsen's process, namely, digestion with very dilute sulphuric acid under 9 atmospheric pressure, with *Excoecaria agallocha* the yield of sugar was about 40% of the weight of dry sawdust. Of this about 70% was readily fermentable, giving approximately 39 gallons of absolute alcohol, a figure practically double of what was obtained in the past. With appropriate figures of cost. a gallon of absolute alcohol from *Excoecaria agallocha* would work out at 6·05 annas. Given a continued supply of this wood, there is thus an excellent prospect of power alcohol industry in the province of Bengal.

100. The constituents of *Plumbago Zeylanica* Linn.

M. C. TUMMINKATTI.

'Plumbagin,' the active principle of the drug, has been isolated in a pure form. It forms orange yellow silky needles melting at 78°C. It is soluble in most organic solvents and in alkaline solutions with formation of a crimson or pink colour. The combustion and the molecular weight determination indicate an aromatic ring compound. The deep red colour with ferric chloride solution indicates a phenolic hydroxyl group in the compound. The benzoyl derivative melts at 146°C. Further physical and chemical properties are being studied with a view to determine the constitution.

101. A micro-method for the analysis of proteins.

N. NARAYANA *and* M. SREENIVASAYYA.

Van Slyke's well-known method of protein analysis has been extended and modified for dealing with 100 to 200 miligrams of substance, a twentieth of the quantity usually employed for a micro-analysis. The precipitation of the hexone bases by phosphotungsic acid, which is affected by the presence of salts, is controlled by the effective removal of the hydrochloric acid from the protein hydrolysate in vacuo over freshly burnt lime. Arginine is estimated by flavionic acid and histidine by bromination. Total mono-amino and diamino nitrogen is estimated by the Van Slyke micro-apparatus. Cystine is estimated by a micro-estimation of sulphur after Pregl. Tyrosine is determined colorimetrically.

102. Studies in sap analysis.

M. SREENIVASAYA *and* B. N. SASTRY.

(1) Carbohydrates in saps.

The estimation of Sugars in saps is complicated by the presence of interfering impurities such as tannins, gallic acid, dextrins, proteins and similar bodies. Precipitating agents like basic lead acetate, dialysed iron, fibrous alumina, mercuric chloride, etc. have proved unsatisfactory

in one way or another. A very suitable method consists in the preliminary removal of dextrins and the greater part of the proteins by an addition of 10 volumes of 95% alcohol containing a little ammonia. The alcoholic filtrate is concentrated on a waterbath, tannins, etc., are eliminated by dialysed iron, and the clear filtrates used for the sugar estimations by Bertrand's method. The direct reducing sugars are estimated as dextrose, the Citric acid hydrolysis gives cane sugar, and the HCl hydrolysis gives Maltose. Invertase and Maltase are also being tried for the estimation of Sucrose and Maltose.

The saps can also be absorbed on fat free filter paper, extracted by 95% alcohol containing a little Ammonia and the alcoholic extract treated as above. This modification gives excellent results.

103. A comparative study of different methods for the estimation of pentosans.

D. D. Deshapande *and* Roland V. Norris, Bangalore.

A comparison of the phloroglucin method of Tollens, the barbituric acid method of Jagger, Jelle's bisulphite—Iodine method and various colorimetric methods.

104. The estimation of pyruvic acid.

B. H. Krishna.

Description of a method suitable for estimation of small quantities of pyruvic acid, from 2 to 20 mgms, in biological fluids. The acid is reduced to lactic acid by Zinc and H_2SO_4 in the presence of a trace of copper sulphate. The resulting lactic acid is oxidised to acetaldehyde which is estimated by Clausen's method of titration against Iodine. A condensing unit is described by which the aldehyde can be transferred into the receiver by aeration with carbon-dioxide without any water passing into the receiver. The experimental errors involved and the corrections required to allow for these are discussed.

105. The action of tannase on tannic acid.

P. D. Dalvi *and* Roland V. Norris, Bangalore.

An investigation of the factors influencing the action of tannase derived from Aspergillus and other moulds.

106. Diastatic activity of spiked sandal leaves.

M. Sreenivasayya *and* B. N. Sastry.

The excessive accumulation of starch in the leaves and stems of spiked sandal has been accounted for by the supposition that the poor diastatic activity of spiked materials does not allow the rapid translocation of the starch. Experiments carried out to verify this point showed us that, contrary to the above supposition, the starch hydrolysing capacity of the spiked leaves is invariably greater than that of healthy leaves. This has been further confirmed by the enzyme analysis of saps. The greater diastatic activity of spiked leaves does not appear to be due to the presence of any associated activator. The starch hydrolysis has been followed and it has been shown that starch splitting by the spiked-leaf-diastase and healthy leaf-diastase are different, the saccharifying capacity of the former being greater.

107. Physical chemistry and biochemistry of haemolysis.

K. C. SEN, Allahabad, *and* S. K. BASU, Calcutta.

A large amount of work has been done on the haemolysis of red blood corpuscles by haemolytes, but no satisfactory explanation has yet been given. In order to find out a suitable explanation, the present authors have carried out a large number of experiments on this subject. The experiments have been divided into two main parts, namely, first, a colloid chemical study of the corpuscle constituents such as lecithin, cholesterol, hemoglobin and albumin, and secondly, the homolysis of sheep's red blood corpuscles by bile salts and their inhibition by normal serum and egg protein. The haemolysis of sheep's erythrocytes and horse erythrocytes by heavy metals and by acids, as well as the behaviour of saponin, of alkali and of hypotonic solutions as hemolytes have been discussed. The following summary gives the main results obtained.

1. Haemoglobin forms a negatively charged colloid in water. Acids sensitise and alkali peptises the sol. Towards electrolytes it behaves like a typical hydrophobic sol. The importance of keeping blood alkaline in normal health is obvious because otherwise the hemoglobin would get precipitated and hence would lose its power of forming oxi-hemoglobin.

2. Haemoglobin sol is sensitised by alcohols, lecithin, albumin and saponin. In alkaline solution, however, lecithin does not sensitise the sol. Mixtures like barium chloride and caustic potash and potassium chloride and caustic potash have a considerable antagonistic action. Saponin precipitates the hemoglobin sol in slightly acid medium, but not in alkaline medium. Soaps (alkali) have a great peptising action. Sodium taurocholate has also a peptising action.

3. The lecithin sol behaves like a hydrophillic colloid. With heavy metals, haemoglobin has a sensitising action.

4. Lecithin stabilises cholesterol considerably, but in presence of excess of cholesterol, it is itself sensitised.

5. Saponin and sodium taurocholate peptise lecithin.

6. An experimental study has been made on the inhibitory effect of blood serum and egg protein on glycocholate and taurocholate hemolysis of sheep's red blood corpuscles. It is shown that this effect is only a special case of the general antagonistic action between a sensitising and a peptising agent in diphasic systems.

7. It has been found that glycocholate is a much stronger hemolysing agent than taurocholate.

8. The mechanism of the haemolysis of red blood corpuscles by haemolytes has been discussed. It is shown that the corpuscle membrane is in the colloidal state, and haemolysis may occur either due to an extreme coagulation whereby cracks will be formed, or by extreme peptisation whereby all the particles will go into apparent solution thus loosening the whole structure. In some cases it may be due to a pure osmotic effect where a mechanical rupture of the membrane is possible. This view will explain the following cases:—Haemolysis by hypotonic solutions, by acids or alkali, by saponin, soap and bile salts, by narcotics and possibly that due to bactericidal action.

108. A biochemical investigation of healthy and spiked sandal twigs.

M. SREENIVASAYA *and* D. A. RAMA RAO.

A systematic analysis of twigs from two sandal areas reveals the interesting facts that the spiked specimens contain more nitrogen and probably more carbohydrate material than the healthy tissue but less of some of the mineral constituents than the healthy ones. The starch content of the alcohol extracted residue is under investigation.

109. Studies in Cholam diastase. Part 1: electrodialysis and electro-osmosis of Cholam diastase (Preliminary note).

D. Narayanamurti *and* Roland V. Norris, Bangalore.

By electrodialysis *cholam* malt diastase can be purified and considerably increased in activity. The ash and protein content are much reduced by this method.

An attempt was made to test the two-enzyme theory of diastase by electro-osmotic experiments. Preliminary experiments conducted in a 5 celled apparatus indicate some evidence in favour of the theory, the ratio, liquifaction power, saccharification power, being different in the different fractions.

Some electro-ultrafiltration experiments with diastase are also described.

110. Kinetics of diastatic action.

D. Narayanamurti *and* Roland V. Norris, Bangalore.

The kinetics of the hydrolysis of starch by cholam diastase is discussed and an explanation for the divergencies in the results of various observers sought for. Experiments on the hydrolysis of potato, rice and *cholam* starches and oyster glycogen are described. In agreement with other observers glycogen is found to be the most resistant. Experiments designed to elucidate the difference are described and the probable causes for the variation in the resistance of the different starches discussed.

111 A bio-chemical study of spike disease of sandalwood.

A. V. V. Iyengar *and* Roland V. Norris, Bangalore.

A comparison of the composition of the leaves of the healthy and diseased trees and a physico-chemical study of the leaf sap. Carbohydrates and nitrogen are both increased in the diseased leaf while a diminution occurs in some of the mineral constituents.

112. Effects of Hydrogen-ion concentrations on rice cultures.

S. K. Mitra *and* Lokenath Phukan, Jorhat, Assam.

Effects of hydrogen-ion concentrations on rice cultures were studied with Knop's Solution as the standard nutrient solution and with hydrochloric acid and caustic soda as the adjusting mediums the concentrations of which varied from 0·001% to 0·01% and 0·001% to 0·05% respectively. The *PH* values of the solutions ranged from 3·0 to about 8·4. The experiment was continued with one-month old seedlings for a fortnight and the total length of roots in millimeters was taken as the criterion of growth.

The results were as follows:—

1. The seedlings showed strong acid toxicity at a concentration of 0·002% HCl, whereas higher concentrations were distinctly inhibitory to root growth. With the addition of alkali, the roots developed far better and the highest root development was shown at a concentration of 0·3% NaOH.

2. A definite relationship was found between the hydrogen-ion concentrations of the culture solutions and their corresponding root lengths, which showed a steady increase with the higher *PH* values. *PH* 3·9 was distinctly toxic whereas *PH* 3·3 was extremely toxic to root growth. At acidities less than *PH* 6·0, the development of roots was below normal but beyond this it was quite satisfactory. The highest root growth was

attained at *PH* 7·9 but further on a drop was shown at *PH* 8·4 which is, however, not quite confirmatory and requires further experimentation.

113. Effects of Shive's three-salt nutrients on rice seedlings.

S. K. MITRA *and* LOKENATH PHUKAN, Jorhat, Assam.

Following Shive's procedure an experiment on the effects of the three-salt nutrients of mono-potassium phosphate, calcium nitrate and magnesium sulphate was tried on the development of roots in rice seedlings. The nutrient solutions were arranged to give all possible combinations in variations of one-tenth to eight-tenths of the total osmotic concentration of 1·75 atmospheres, for each of the three salts used. The results of the experiment were as follows:—

1. The culture showing the highest root development had five-tenths of its total osmotic concentration due to monopotassium phosphate, two-tenths due to magnesium sulphate and three-tenths due to calcium nitrate. Similarly, other high root developments were characterised by high concentrations of monopotassium phosphate and low concentrations of calcium nitrate and magnesium sulphate.
2. The culture showing the lowest root development had three-tenths of its total concentration due to mono-potassium phosphate, five-tenths due to calcium nitrate and two-tenths due to magnesium sulphate. The region of low root development was characterised by low concentrations of mono-potassium phosphate and high concentrations of calcium nitrate or magnesium sulphate or both.
3. The best and the worst cultures contained the metallic ions of magnesium, calcium and potassium in the proportions of 0·56 : 0·43 : 1·00 and 0·93 : 1·20 : 1·00 respectively.

114. On a new device for maintaining better vacuum in the vacuum pan apparatus.

N. G. CHATTERJEE.

115. A history of chemistry in the Punjab.

H. B. DUNNICLIFF *and* RAMA KRISHNA BAHL, Lahore.

The paper records the development of the subject from 1849 to the present time in Geology, Medicine, Agriculture and Education.

116. The action of sulphuretted hydrogen on potassium chromate solution.

H. B. DUNNICLIFF *and* CHAMAN LAL SONI, Lahore.

In dilute solutions (2-15% K_2CrO_4) the colour changes from yellow to green with evolution of heat. Chromium is recovered quantitatively as hydroxide and the potassium is obtained as pentasulphide and thiosulphate.

117. The action of substituted amines on camphoric anhydride. Bromocamphoranilic acids and camphorobromophenylimides.

MAHAN SINGH, RAM SINGH *and* KISHEN LAL, Lahore.

The reaction

$$C_8H_{14}\left\langle \begin{matrix} CONHC_6H_4\underline{R} \\ COOH \end{matrix} \right. \longrightarrow C_8H_{14}\left\langle \begin{matrix} CO \\ CO \end{matrix} \right\rangle NC_6H_4\underline{R} + H_2O$$

is dependent on the nature of the Group *R*. Bromanilines have been condensed with camphoric anhydride. The yields of the imides are, *p.*, 40%, *m.*, 25%, *o.*, 5%. The substances are optically active and their rotations have been found in various solvents.

118. The solubility of mercuric bromide in ethyl alcohol.

KISHEN LAL *and* H. B. DUNNICLIFF, Lahore.

The values found by the method of Chugaev and Khlopin (Z. Anotg. Chem. 1914. p. 159) are consistently higher than those recorded by Timofeiew.

119. The causes and prevention of saline efflorescences on Masonry. (Preliminary Note.)

H. B. DUNNICLIFF *and* RAMA KRISHNA BAHL, Lahore.

The nature of a number of efflorescences has been examined and attempts made to find if any changes which should cause such efflorescences are developed during the baking of the bricks.

120. Compounds of hexamethylene tetramine with certain salts of silver and other metals and the influence of anionic volume on the capacity for association by the central positive atom.

PRIYADA RANJAN RÂY *and* JYOTIRMOY DAS GUPTA, Calcutta.

It has been established by Ephraim (Ber, 53, 548, 1920; 54, 973, 1921) that the capacity of a cation to associate with neutral molecules increases with the anionic volume. With a view to further test the validity of this conclusion the authors have prepared a number of well-crystallised compounds of hexamine with various silver salts like cyanide, cyanate, thiocyanate, perchlorate, chromate, dichromate, molybdate, tungstate, sulphate and selenate. From a study of the nature and composition of these compounds as well as of some other hexamine silver salts previously described by others, it was concluded by the authors that Ephraim's generalization holds good also in the case of hexamine compounds. Anomalous result in the case of silver fluoride is attributed to the formation of a complex anion of silver and fluorine due to polymerization. With a common anion the capacity of the cation for association has also been studied in the case of certain newly prepared hexamine compounds with cyanides of copper, cadmium and silver. The composition of these latter compounds has also been explained in the light of Ephraim's conclusion. The failure of tellurate, phosphate, borate, iodate, arsenite and arseniate of silver to associate with hexamine molecules has also been accounted for on similar grounds. All the hexamine compounds described in this paper have been obtained by a method based on the principle of substitution from an ammoniacal solution of the salts.

121. Active aluminium.

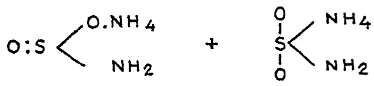
G. SAMBAMURTI *and* N. L. NARASIMHAM, Rajahmundry.

Aluminium becomes activated by amalgamation and the activated metal serves as a good reducing agent in a neutral medium. The activated metal readily oxidises in moist air having traces of CO_2.

122. The interaction of sulphur dioxide and ammonia.

G. SAMBAMURTI *and* M. N. L. NARASIMHAM, Rajahmundry.

Dry sulphur dioxide and dry ammonia interact producing two isomers of the constitution.



123. Equilibrium diagram of the system arsenic-antimony.

Q. A. MANSURI, Aligarh.

The system has been studied both thermally and microscopically with Arsenic and antimony alloy in all proportions. The curve gradually rises from the melting point of antimony to that of arsenic and the diagram is similar to that of copper and nickel. The two metals form a continuous series of mixed crystals which are hexagonal in shape.

124. The system Water—Potassium nitrate—calcium nitrate at 25°C.

MOHAMMAD ABDUL HAMID *and* RAM DAS.

On account of the relatively great electroaffinity of the nitrate ion, the formation of double nitrates is found to occur in but few cases. These double nitrates are formed only when one of the metals has a valency greater than two or when one metal is of high atomic weight and volume.

The unexpected formation of a double nitrate of Potassium and Barium, $K_2Ba(NO_3)_4$ [Wallbridge, Amer. Chem. Jour. 32, 251, 1904] led us to conclude the possibility of the existence of similar double nitrates of Potassium with other alkaline earth metals. In the case of Calcium no evidence of double nitrate formation has been found from our investigation of the system $H_2O-KNO_3-Ca(NO_3)_2$ at 25°C.

A number of hydrates of Calcium Nitrate have been reported in literature. Our observations that the only stable hydrate at 25°C is the Calcium nitrate tetrahydrate, $Ca(NO_3)_2.4H_2O$ agree with those of Basset and Taylor [Jour. Chem. Soc., 101, 576, 1912].

125. Heterogeneous equilibria between the sulphates and nitrates of sodium and magnesium and their aqueous solutions.

MOHAMMAD ABDUL HAMID *and* AMBA PARSHAD.

The quaternary system $H_2O-Na_2SO_4-NaNO_3-MgSO_4-Mg(NO_3)_2$ has been investigated at 25°C. In addition to the solid phases met with in the ternary systems at this temperature, a new surface appears in the quaternary system which probably represents the saturation field of the lower hydrate or hydrates of Magnesium Sulphate.

126. Iodates of titanium.

PRIYADA RANJAN RAY *and* HARIBOLA SAHA, Calcutta.

By the action of iodic acid dissolved in nitric acid (1 : 3 by volume) upon freshly prepared titanic acid dissolved in the same solvent, a basic

iodate of titanium has been obtained. The individuality of the substance in question has been established by the fact that the same product was obtained from the liquid phase of varying concentration. It is preferable to regard the compound as a complex tetra-hydroxy di-iodate titanic acid for several reasons. It is converted by heating to 100°C to the proper basic titanium iodate. Salts of complex hydroxy-iodato-titanic acid have also been prepared.

127. A note on a new method of volumetric estimation of mercuric oxide.

PRIYADA RANJAN RÂY *and* JYOTIRMOY DAS GUPTA, Calcutta.

Mercuric oxide completely dissolves in sodium thiosulphate solution in the cold with liberation of an equivalent amount of alkali and formation of the complex mercury sodium thiosulphate. The reaction is a quantitative one and the amount of mercuric oxide in a sample can be easily determined by titrating the alkali disengaged. The excess of thiosulphate present does not interfere with the titration of the alkali. This furnishes a rapid method of evaluating mercuric oxide in commercial samples of the same, in basic salts of mercury and in various medicinal preparations. It has got sure advantages over the potassium iodide method of Rupp and Schirmer (Pharm. Zeit. 1908, 53, 928) being much less expensive; the results however are equally good.

128. Catalytic decomposition of nitrous oxide.

M. S. SHAH.

In the analytical investigation of the reaction ($C+N_2O$) at various temperatures it was found that nitrous oxide decomposes at a lower temperature in presence of charcoal than when heated alone. This suggests that the behaviour of charcoal is catalytic. On examination of the catalytic influence of thoria, alumina, titania and platinum, a similar lowering in the temperature of decomposition of nitrous oxide was observed. Comparison of curves for nitrous oxide decomposed in an hour against temperature in presence of these substances showed that these substances act as catalysts in the order: thoria, charcoal, alumina, platinum black, titania and platinum foil.

129. Interaction between hydrated copper oxide and neutral salt solutions.

M. P. VENKATARAMA IYER.

Hydrated copper oxide thoroughly purified by repeated washing and subsequent electro-dialysis to remove the last traces of alkali is found by electro-osmotic measurements to be positively charged in contact with conductivity water. It develops appreciable quantities of alkali when shaken up with solutions of neutral salts. The pH developed depends upon the effect of the anion and not very much on the cation used. The variation of the electrical charge of the substance with various electrolytes can be correlated to the pH measurements. The total quantity of alkali liberated by repeated shaking of a given quantity of the sample with potassium and barium chlorides has been measured and found to be a constant quantity. The pH, after attaining the value 7·6, remains constant on subsequent shaking with potassium chloride. The sample of

the hydrated copper oxide has been shown to absorb alkalies by measurements of the electrical conductivities of the alkali solution before and after adsorption. The results obtained are in strong support of the theory of the nature of the interface as put forward by Mukherjee.

130. Reduction of copper salts to metallic copper by glycerol.

B. K. VAIDYA *and* C. N. SHAH, Ahmedabad.

On heating glycerol solutions of copper salts, decomposition occurs, whereby metallic copper is precipitated, except in the case of cupric chloride, which yields cuprous chloride.

The temperature at which the reaction occurs is different for different salts. With copper sulphate the reduction takes place at 210°C, with copper nitrate at about 180°C and with copper acetate and copper chloride at 190°C. In all cases an intermediate stage in the reduction, namely, the formation of yellow cuprous oxide, can be marked. The vigour of reduction is considerable in each case, with copper sulphate the action being almost violent.

Besides metallic copper, other products of reaction are, acrolein, acrylic acid and the acid obtained from the decomposition of the respective salts.

The similarity in the nature of the reactions with all copper salts indicates that the glycerol compound of copper is formed in all probability, and this then decomposes into copper, aldehyde and other products. It is also likely that the salts, becoming anhydrous at a higher temperature, remove water from glycerol, thus producing acrolein, but their subsequent reduction to metallic copper is strange.

The reaction is being studied further.

131. A new method of preparing hyponitrites and preparation of some new hyponitrites.

P. NEOGI *and* BIRENDRA LAL NANDI, Calcutta.

In this paper the reducing action of magnesium amalgam on metallic nitrates and nitrites has exhaustively been studied when it has been found that this reaction can conveniently be made a method of preparing hyponitrites. With the help of this method hyponitrites such as those of Na, K, Ca, Sr, Ba and Pb have been prepared and several new hyponitrites such as those of Cd, Zn, Mg, Li, Rb and Cs, have been isolated and analysed. Magnesium hyponitrite has, however, been obtained in solution only. Basic hyponitrites of cadmium and lead have also been obtained. Hydroxylamine is also obtained in all cases of reduction excepting in the case of rubidium and coesium nitrates. This method has the advantage of yielding the hyponitrites *directly* by the reduction of their nitrates and nitrites, whilst previously most hyponitrites were prepared by double decomposition with sodium hyponitrite. The success in the preparation of the hyponitrites lies in the insolubility of the magnesium hydroxide formed during the reaction, whilst caustic Soda which is formed in large quantities in Divers' method of using sodium amalgam is difficult to remove in the case of soluble hyponitrites and reacts with the nitrates of heavy metals precipitating their hydroxides.

Nitrates of other metals do not yield hyponitrites. Copper nitrate gives basic copper nitrate, $Cu(NO_3)_2 . 3Cu(OH)_2$ and silver nitrate is reduced to metallic silver. Cobalt and nickel nitrates were reduced to their hydroxides and mercuric and mercurous nitrates yielded the respective oxides. Ammonium nitrate yielded the nitrite, and free dilute nitric acid yielded hydroxylamine which wasi solated as the sulphate in the pure condition.

132. A new method of preparing mercury compounds of phenols, phenol-ethers and aromatic amines.

P. Neogi *and* Manas Prasun Chatterjee, Calcutta.

Aromatic compounds of mercury had hitherto been prepared by Dimroth, Pesci and several others by heating the organic compounds with mercuric acetate. Dimroth has reported that mercuric chloride has little or no action on aromatic compounds. P. Neogi and S. Neogi (Trans. Chem. Soc. 1927, pp. 30–37) have however recently shown that a distinct period of induction exists when mercuric chloride and sodium bicarbonate are allowed to act which can be indefinitely prolonged by the addition, amongst other things, of glycerol. Advantage has been taken of this phenomenon in this paper to prepare mercury organic compounds, mostly in the cold, of phenols, phenol-ethers and amines by adding the organic compound to the mixture of mercuric chloride and sodium bicarbonate in the presence of glycerol. In this way mono and dioxy-mercuric-chlorides of phenol, catechol, quinol, resorcinol, phoroglucinol, orcinol, guaiacol, aniline, methylaniline and dimethylaniline have been prepared. In the case of substances not soluble in water alcoholic solutions are taken.

133. A new method of effecting geometrical inversion: Part I: Conversion of maleic into fumaric acid.

P. Neogi, Sukumar Neogi *and* Manas Prasun Chatterjee, Calcutta.

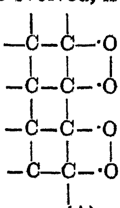
Skraup has shown that maleic acid is converted into fumaric acid by the joint action of Sulphur dioxide and Sulphuretted hydrogen whilst neither of them singly has any action. He developed a 'resonance' or 'vibration' theory of explaining geometrical inversion on the strength of this phenomenon. Whilst searching for further experimental confirmation of Skraup's work we have found that neither manganese dioxide nor sulphur dioxide inverts maleic acid, but when sulphur dioxide is passed into a solution of maleic acid in which manganese dioxide is suspended it is converted into fumaric acid, the yield being greater than in Skraup's experiment. The conditions under which the inversion takes place have been studied in detail.

134. Combustion of charcoal in oxygen, nitrous oxide and nitric oxide.

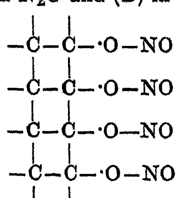
M. S. Shah.

The combustion of purified sugar charcoal in oxygen, nitrous oxide and nitric oxide has been studied both by a static and a dynamic method.

The qualitative and quantitative investigation of these reactions show that the probable mechanism in the process of combustion before CO and CO_2 are evolved, is (A) in O_2 and N_2O and (B) in NO.



(A)



(B)

The union between carbon and oxygen is purely chemical as fixation of oxygen also occurs as a result of chemical decomposition of N_2O and NO. This union is very feeble below $-78°C$, moderately so between $-78°C$ and $50°C$ and increases in strength above $50°C$ when the temperature is raised.

The spectroscopic examination revealed that the flame combustion of charcoal in O_2 and N_2O is due to the oxidation of CO in the gaseous phase by N_2O or O_2. No flame is observed in the reaction with NO; this is due to the oxidation of CO by NO at the time of its formation in the pores of charcoal whereby the possibility of a gaseous reaction is obviated.

The view that CO_2 is the first product of combustion and that CO is obtained on subsequent reduction is found to be untenable. It is highly probable from the difference in the behaviour of N_2O and NO towards charcoal and from the proportion of CO evolved in Oxygen experiments, that CO is the primary product and CO_2 is obtained along with it due to subsequent oxidation of CO by the fixed or the adsorbed layer of oxygen in charcoal.

The results throw some light on the mechanism of adsorption. The process consists of surface condensation alone in the cases of N_2O, CO, CO_2 and N_2, and of both surface condensation and chemical reaction in the cases of O_2 and NO at $0°C$.

Similar attempts are at present made to elucidate the mechanism of the combustion of sulphur in these gases.

135. Examination of the active principle of Indian henna.

SYED BASHIR ALI.

Water extract is treated with lead acetate, lead removed by sulphuretted hydrogen, and the active principle extracted by means of Benzene.

(*a*) It is quite a pure product for it gave a constant M.P.

(*b*) It is easily oxidisable, the colour changes to dark-red even on exposure to air. The oxidised product can be easily reduced by Zinc and Hydrochloric acid.

(*c*) The formula found differs from those given by previous workers.

136. Melting points and saturation points of sodium thiosulphate and sodium sulphate by the conductivity method.

CHETAN ANAND *and* HAR GOBIND.

The conductivity method has been used by different observers for determining the transition points of salts in aqueous and non-aqueous solutions. Resistance of solutions of the salts are measured at different temperatures and the resistance-temperature graphs on being plotted indicate abrupt changes at the transition points. The method was applied to sodium thiosulphate and sodium sulphate in aqueous solutions. These salts have a comparatively low melting point, are highly soluble in water, and can easily be obtained in the supersaturated condition. Therefore if transition occurs at the melting point in the solutions, it will be indicated on the graphs. Resistances of various solutions were measured over a range of temperatures which went above and below the melting point of the salts and the saturation points of the solutions. The resistance-temperature graphs for Sodium Sulphate show at its melting point ($33°C$) a clear transition point for all concentrations and also a second transition point at the saturation point which varies with the strength of the solution. The graphs for Sodium Thiosulphate give two transition points. The melting point varies between $45°C$ and $50°C$ with different concentrations.

137. Inversion of cane sugar by tartaric acid.

DHARM SINGH, KISHEN LAL *and* CHETAN ANAND.

The action continues for several days at ordinary temperatures and can be studied conveniently by a polarimeter. Mixtures of cane sugar and tartaric acid were prepared in varying proportions, and their activities measured after equal intervals of time. The results are graphically shown. The rate of inversion is comparatively slow when the ratio of the acid to sugar is the lowest. The curves obtained are very striking. The activity of tartaric acid, as would be expected, plays no part in the reaction. The graphs for the more active and the less active varieties run exactly parallel to each other. The sugar is completely inverted after boiling; the activity of the acid appears only as an additive property.

Observations on different concentrations of sugar with a constant quantity of acid indicate that the rates of inversion follow a straight line law; for a given concentration of sugar acted on by different quantities of acid, the rates of inversion do not show a simple relation.

138. The condensations of esters with Resorcin, Di-methylaniline and Diethyl-m-aminophenol.

R. N. SEN *and* ASHUTOSH MUKHERJEE.

Previously Resorcinol and Pyrogallol were condensed with methyl Salicylate to produce compounds of the Benzein series. (Sen and Guha Sarkar Journal Ind. Chem. Society Vol. I issue No. 2 pp. 157.)

In elaboration of that reaction, Benzoic ester has now been condensed with resorcinol by heating to 180°C in the presence of $ZnCl_2$. Resorcinol-Benzein is produced with the intermediate formation of 2-4 Dioxy Benzophenone which has also been isolated. The following other esters have also been successfully condensed with resorcin :—O-nitro-, O-amino-, and p-amino-, Benzoic esters; naphthoic ester; oleic and stearic esters; and the effect on the reactivity and the yield as also upon the colour and fluorescence of the products has been studied. The compounds dye wool and silk yellow to brown shades while the Bromo derivatives dye red shades.

The natural oils, being analogous to esters, have been similarly condensed with resorcin. Cocoanut oil, olive oil and castor oil have been made to yield dyes in this way, producing yellow to brown shades on wool and silk, bright red shades being produced by the Bromo compounds. Benzoic ester, O-hydroxy, O-amino and p-amino- Benzoic esters and naphthoic ester have also been condensed with Di-methylaniline in the presence of $ZnCl_2$ and $POCl_3$ to give malachite green and dyes of the malachite green series. The dye base is formed directly and so the oxidation of the leucobase is not necessary.

Rhodamines have been obtained by the condensation of Di-ethyl-m-aminophenol with Benzoic ester, anthranilic ester and stearic ester in the presence of $ZnCl_2$ Incidentally in the case of Benzoic ester an acridine dye, Di-oxyphenylacridine, has been obtained with HCl as condensing agent.

139. Condensation of levulinic acid ($\overset{\delta}{C}H_3\,CO\,\overset{\beta}{C}H_2\,\overset{\alpha}{C}H_2\,COOH$) with aldehydes (—CHO).

R. N. SEN *and* BIRESH CHANDRA ROY.

Levulinic acid was previously condensed with benzaldehyde, furfuraldehyde, and a few substituted benzaldehydes by several investigators, (Erdmann 1886, Ber. 18,3441-43, Annalen 258,129-33; Erlenmeyer-Ber 23,74-76; Ludwig and Kehrer-Ber 24,276-78; Erdmann and Kehrer-Ber 26,345; Meigash-Monatsch 26,2675-77; Borsche-Ber 1915, 48,842-49).

In the present investigation the acid has further been condensed with various aldehydes (Benzaldehyde, monohydroxy benzaldehyde, resorcyl aldehyde, beta-naphthyl aldehyde, nitro-benzaldehyde, furfuraldehyde, citral, piperonal, anisaldehyde, vanilin, glucose) with interesting results, Alpha-condensations taking place in presence of acetic anhydride, beta-condensations taking place with dry HCl gas whereas the condensation takes place at the delta-position when dilute caustic soda solution is the condensing agent.

Alpha-beta and delta-beta condensations (dibenzylidine compounds) have also been effected in many cases carrying out the reactions successively with different condensing agents.

The condensation products have afforded further opportunities of studying the possibilities of the formation of interesting ring compounds by the action of suitable dehydrating agents.

With acetic anhydride as the condensing agent the beta-condensation products have in all cases yielded naphthalene derivatives; whereas the delta products under similar circumstances have yielded a new type of cyclic compounds which may be looked upon as being formed by the coalescence of an eight membered ring with a benzene nucleus.

By condensing m-nitro and m-hydroxy benzaldehydes with levulinic acid in presence of dry HCl gas, naphthalene derivatives are formed at once beta-condensations and ring formation taking place simultaneously.

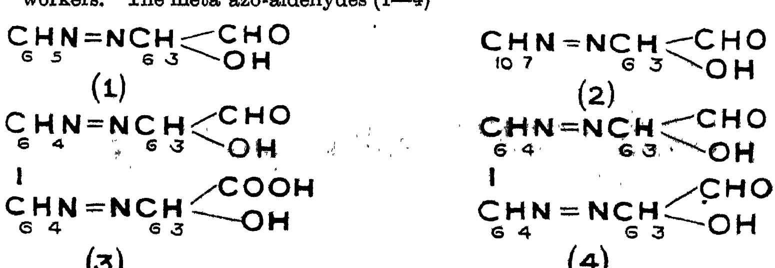
It is remarkable however that in the case of piperonal as well as vanilin naphthalene derivatives are also obtained at once.

In the case of O-hydroxy compounds as well as with several delta-condensation products seven membered and five membered lactones have been obtained, the former exhibiting marked dyeing properties.

140. Studies in Azo-triphenylmethane and Azo-pyronine dyes.

R. N. SEN *and* B. B. GHOSH.

The aim of the present investigation was to study the influence of the azo and triphenylmethane groups in the meta position, on one another, as has been done in the case of the para position by previous workers. The meta azo-aldehydes (1—4)



(1) (2) (3) (4)

have been condensed (*a*) with dimethylaniline and o-cresotinic acid to give triphenylmethane dyes and (*b*) with resorcinol, pyrogallol and diethyl-m-aminophenol to give pyronine dyes. The aldehydes themselves have been obtained by coupling salicylaldehyde with the corresponding diazo compounds.

It has been found that (1) introduction of one azo group into a triphenylmethane or a pyronine dye intensifies the colour, (2) a second azo group intensifies it still further (though to a small extent) while (3) a second triphenylcarbinol group into a dye containing two azo and one triphenylcarbinol groups diminishes it (colour of the second order.)

The leuco cresotinic acid compounds from (3) and (4) possess direct affinity for cotton, which disappears on oxidation to the carbinols. The triphenylcarbinol group in its quinonoid form is probably responsible for this disappearance.

A great difference between the para and the meta compounds is that the yellow shade on wool produced by the leuco cresotinic acid compounds of the meta series is changed only to olive brown by after-chroming and are only feebly polygenetic, while in the case of the para series, the yellow shade passes through maroon to dark green and black by similar treatment and the carbinols are remarkably polygenetic.

141. On the reactivity of ortho-diketonic groups placed between two nitrogen atoms.

ANUKUL CHANDRA SIRCAR *and* PRAN KUMAR DE.

In attempting to prepare azine derivatives by the condensation of Ortho-diamines with diphenyl- thioparabanic acid and similar other bodies, it has been found that the ortho-diketo groups when placed between two nitrogen atoms behave quite differently towards ortho-diamines than when placed between two carbon atoms,—as in phenanthraquinone. Thus by the condensation of ortho-phenylene diamine with diphenyl-thio-parabanic acid no azine could be obtained, but phenylene-oxamide, phenylene-thiourea and aniline were isolated from the reaction mixture. Dinitro-diphenyl-thio parabanic acid and diphenyl parabanic acid behave exactly in the same way. An explanation of the mechanism of the reaction is given.

142. Equilibrium diagram of the system lead-arsenic.

MOHAMMAD OMAR FARUQ.

Arsenic alloys with Lead in all proportions. The diagram was studied up to 60% Arsenic. Lead does not dissolve any Arsenic at its melting point but at higher temperatures two layers are formed. The lower layer being Lead containing a small quantity of Arsenic in it and the upper layer of Arsenic with small quantity of Lead dissolved in it.

Section of Zoology.

President :—Dr. B. Sundara Raj, M.A., Ph.D.

Presidential Address.

A Plea for a Neglected Aspect of Biology.

Friends,

I cannot express in adequate words, my sincere thanks for the signal honour you have done me, by electing me President of the Zoology section of the Science Congress this year. My hesitations in accepting your gift were great, when I looked at the list of my distinguished predecessors; and even now, I am far from sure that I have deserved the distinction you have so generously bestowed upon me. The accepted convention of this august assembly imposes upon me the duty of delivering a presidential address, on some aspect of the Science we represent, which is of immediate interest and significance, not only to members of this section, but of other sections and to those of the general public who have an interest in zoology. It is no light responsibility to be called upon to address a gathering of Indian Zoologists. The choice of a suitable subject has weighed upon me heavily for a long time, especially as I found that others before me had already dealt with those aspects of the subject with which I may claim practical acquaintance. At least two presidents before me have dealt with Fisheries Science and Oceanography, and though it is expected that the President should deal with some subject in which he has himself been interested, I have, reluctantly, to set aside my temptation to speak on that branch of zoological research. Further, I am in entire agreement with my distinguished predecessor, Lt.-Col. Sewell, that presidential addresses should not be confined to any one particular branch of zoological research, but should deal with some aspect that has a general interest for all. I, therefore, crave your indulgence for departing from the beaten track and for choosing for to-day's discourse, a theme, which is of the very greatest importance and interest to *humanity*, even though, it may not be of immediate practical concern to any of my audience.

Nevertheless, the theme I have chosen has a direct local and immediate significance. India is renowned for its great and ancient schools of thought. Metaphysical Biology, therefore, offers a congenial field for the ceaseless labours of Indian Zoologists, in the cause of science and philosophy alike. The whole realm of biological science presents everywhere philoso-

phical problems. I need only refer to the extensive literature, for instance, relating to evolution and heredity, materialism and vitalism, pan-genesis and epi-genesis and other moot problems of biology. Interpretations of the results of biology have a profound human interest and cannot, it seems to me, be legitimately eliminated from the scope of biological science and left entirely to be formulated by mere philosophers as has been unfortunately too often the case in the past. I am confident, that, if Indian Zoologists will devote due attention to this neglected field, perhaps the greatest contribution that India has yet to make to the science of life, will be in the field of metaphysical biology.

Disinclined, as biologists generally are, to occupy themselves with philosophical issues, it is not difficult to see that even in the West, the subject has received but scant attention from biologists and philosophers alike. One could almost count on one's finger tips those eminent men who have attempted, throughout the ages, to wrestle with the great problems of biological metaphysics and interpret the implications, the presuppositions, the laws and the results of biological science. As with all such problems, we find the earliest systematic expositions of this subject in the literature of ancient Greece. It is significant that Aristotle, the founder and father of scientific biology, is himself in the front rank of the world's metaphysicians. It is well known, that the influence of Aristotelian conceptions continued to dominate European thought for over fifteen hundred years. One finds the first signs of a departure from the Aristotelian tradition during the *Renaissance.* The assured position of the mathematical and physical sciences at that time furnished the stimulus and material for philosophic reflection, in thinkers like Descartes and Spinoza. Though biological ideas are not absent in these earlier thinkers, we find greater evidences of their influence in the more mature speculations of Leibnitz, one of the world's most original mathematicians and philosophers. During the latter half of the 17th and the beginning of the 18th century, more and more attention was coming to be bestowed on anatomical peculiarities and physiological functions, in the organic world, as evidenced by the researches and discoveries of Harvey, Malpighi, Haller, Linnaeus, Cuvier, Lamarck and a whole host of lesser names. Nevertheless, the foremost philosophers of the time, Hume and Kant, have hardly dwelt on the philosophical implications of biology. It must be noted to the credit of Hegel that he foreshadowed the epoch-making discovery of Darwin by anticipating the evolutionary conception and applying it to work out a universal philosophy. But with Hegel, it is a logical or dialectical evolution of ideas, and not a chronological or historical evolution of life, such as Darwin established. The importance of the Darwinian achievement will be realised when we take note of

how its basic idea has been adopted by all subsequent scientists and thinkers; and how it has since well-nigh revolutionised every sphere of human thought. The serious attempt to work out a philosophy of biology can only be said to have begun in modern times since Darwin. Out of the many such attempts, that have been made, it is sufficient here to mention only the names of Herbert Spencer in the 19th century, and Henri Bergson in our own day. But all these efforts so far made, with few exceptions, seem to confine themselves mainly to the problem of evolutionary biology and its implications. I claim, that the field of biological metaphysics, is far wider than this and is pregnant with as yet unsuspected possibilities and far-reaching consequences.

I propose to direct your attention this evening to this field of biology and to focus your attention, if I may, on one immediate problem that confronts us at the present day. What I shall say in the few minutes that follow will be no more than a few random thoughts that have occurred to me in the course of a busy life crowded with administrative duties, with hardly enough time for fruitful research, or reflection. I make no pretension here to have arrived at any sensational discovery. I shall consider myself amply rewarded, if I succeed in interesting others more fortunately placed than myself in, what seems to me to be, a fresh and profitable line of enquiry, in the hitherto-neglected domain of *philosophical biology.*

The most profound and far-reaching physical theory that the world has ever known is Einstein's Theory of Relativity, which is revolutionising the basic principles of physical science in our day. Has it any reference to biological science? I am convinced that it is destined not only to shed a flood of new light on time-honoured biological controversies, but also to open up fresh and fruitful fields of biological speculation and discovery. I shall now state for what they are worth, certain possible applications of relativity to biology that have suggested themselves to me.

It is true that as biologists, we are concerned only with life; but the life that we are concerned with in our researches is life which has a physical basis and manifests itself at every turn in physico-chemical phenomena. Even the most elementary knowledge of biology is sufficient to show that its subject matter is primarily concerned with the size, shape, age, and activities of living things, which constitute organic phenomena. Of the characters that distinguish one species from another, the most outstanding are anatomical differences, that is differences in shape and size in general terms, and physiological differences such as, birth, growth, age, death, including the nutritive, respiratory, excretory and reproductive functions of the organism. All these involve, without exception, physico-chemical properties and processes such as size, shape, mass, motion, velocity,

molecular and atomic structure, as well as duration or time; to all of which relativity has a direct and vital bearing. Therefore, the application of the principles of relativity to such physical phenomena of life, becomes an imperative duty, if the full implications of biological truth, are to be comprehended.

What are the startling ideas of relativity in this connection? In the first place, Einstein's theory asserts that the actual reality underlying all manifestations we experience in the physical universe is an inextricable blend of what we have so long separately regarded as time, space and matter. According to Einstein, reality is neither spatial nor temporal nor material but a blend of all these. Relativity claims to take us behind our accepted ideas about space, time and matter, as independent entities, to the primitive reality, out of which, human minds have conceived of the ideas of space, time and matter separately. Further, Einstein has shown that space and time intervals between events are not the same for everybody; and that there are irreconcilable differences between the observations of different observers though every one of them may be perfectly accurate and correct in what he observes and measures. In other words our observations of space, mass and time are all relative to each observer and reality consists in that combination of space and time measurements on which all observers concur or agree.

In this way, mass, space, time, force, gravity and the laws of mechanics and dynamics have all been reduced to a simple system of "space time intervals" between "point events" and 4-dimensional geometry of length, breadth, thickness and duration. Relativity has deprived "force" of its supposed reality, and has thus removed the most outstanding anomaly of mechanics, viz., the impossibility of defining force except in terms of mass: while at the same time, mass itself had to be defined in terms of force. "The Newtonian world is a 3-dimensional space continuum, with particles in motion in it, time being necessary to this motion. The world of relativity is a 4-dimensional space-time continuum, with world lines, embedded in it: not world lines in motion in it, for the idea of motion belongs to Newtonian space." Motion and direction are shown to be relative to the observer.

The dimensions of an object, its shape, size and mass, and the space it seems to occupy have all been shown to depend upon its velocity and the velocity of the observer. They are all relative and have no absolute value. We cannot form any idea of absolute space and, therefore, there is no such thing as space. It is our measuring rods that create space. Einstein proves that the mass increases with velocity, that a pound weight, for instance, will double itself if it moves at the velocity of light (161,000 miles per second). Experimental facts

relating to cathode rays and particles shot out by radium confirm Einstein's contention.

Different observers were found to obtain different values for the time interval between two events ; and not one of them could substantiate a better claim than any other to be right. This simply means that time intervals are unmeasurable things. Hence to the relativist who says that everything which is real must be measurable, time intervals are not real things belonging to the events observed, but are variable quantities. imputed to the event by different observers. Thus, space and time intervals have been shown by the relativist to have no fixed or absolute value.

What consequences will inevitably follow to biology from this ? Organic form, size, age and growth, can no longer be dogmatically accepted as absolute facts, without question as hitherto. This seems to undermine the accepted principles and established lines on which biological science has proceeded so long. The first impression is wholly bewildering as it seems to vitiate all biological researches and results. But is this really so ?

Are we to accept the principles of relativity and revise and re-state biological laws and results in relativist terms ; or, does biology present any novel or distinct aspect of the truth which would necessitate a revision of the relativist claims ? It is altogether premature, and indeed, impossible, in the present state of our knowledge, even to attempt to make any pronouncement one way or the other on this momentous question. All that I hope to do is to consider the established principles of relativity in relation to some biological problems that have given rise to historic controversies.

One great problem of biology is that involved in the dispute between Vitalism and Mechanism. Biological phenomena have been interpreted, from very early times, by one or other of these two rival hypotheses. Historically, the mechanistic view may be traced back, to the speculations of Democritus and the Atomists and the classical statement of the vitalistic theory is to be found in the famous Aristotelian conception of "Entelechy."

The great development of the science of Mechanics early in the 17th century led to the conception of Descartes' Automaton. The anatomy and the physiology of the day, conceived of the animal body, as an inorganic machine—" levers of various shapes and orders, elastic parts that pull these levers and channels along which fluids are propelled by the action of a force pump, and are directed, by means of valves." With the great advance made by chemistry towards the end of the 18th century, physical and chemical ideas were imported into biology, to explain life phenomena. The theory of combustion, developed by Priestly and others, revolutionised our concep-

tions of vital activity. Respiration was henceforth interpreted as combustion, and as the source of animal heat. The modern idea of energy derived from steam and other motive powers, influenced physiology, in its turn ; and the transformation of mechanical energy into measurable heat, led to the discovery of the calorific values of food ; and we arrived at the conception, that the oxidation of food in the body became transformed into heat, and heat in its turn transformed into mechanical work. The animal body was, therefore, conceived of, as a thermodynamic machine. About the middle of the 19th century the discovery of crystalloids and colloids in Chemistry and the phenomena of osmosis in Physics profoundly influenced Physiology; and it was said that chemistry of life, is largely the chemistry of colloids. At about the same time, the discovery of catalytic action in chemical processes, explained the mystery connected with the function of enzymes or ferments in the animal body. Though we still speak of enzyme action in relation to bio-chemistry, and catalysis in relation to inorganic chemistry, we know very well, that the two classes of chemical changes are of the same kind. Then also, in the 19th century, chemists like Wöhler and Fischer, succeeded in producing synthetically organic substances such as urea, sugar and polypeptides from mineral substances. The hard-and-fast distinction, that had so long been held to exist, between organic and inorganic chemical compounds, was practically effaced. To-day, we look forward to the time when, all organic compounds, starches, proteids and fats, once considerd peculiar to life, will be prepared artificially, by the chemist. The final achievement of the mechanistic school came early in the present century, when Jacques Loeb demonstrated the possibility of artificial fertilisation of eggs by chemical stimuli. Thus, this most complex of organic phenomena—fertilisation and development—itself proved to be nothing peculiar to life, but capable of a physico-chemical explanation. The mechanistic conception, therefore, has undoubtedly dominated biology and has remarkably advanced our knowledge of living things.

For recent statements of these two rival theories, I need only refer to Ernst Haeckel and Herbert Spencer as philosophical exponents of the mechanistic view, and to Hans Driesch and Henri Bergson as the most famous exponents of vitalistic biology. The mechanistic school maintains that the vital phenomena are only highly complicated products, or manifestations, of physico-chemical processes. On the contrary, the essential contention of the vitalists is that organic phenomena cannot be accounted for in purely physico-chemical terms ; and that they do and must for ever imply or pre-suppose, an incalculable super-mechanical factor, or vital impulse or life force. The battle between the mechanistic and the vitalistic views has not yet been fought to a finish. Meanwhile both theories

claim to hold the field and have to be reckoned with. While it is true, that all biological phenomena have not been reproduced in the laboratory or explained as yet on the analogy of physico-chemical processes or changes, the influence of mathematics, chemistry and physics on biology has led to the increasing application of chemical and physical methods to biological studies; or even to the belief that biological phenomena are analogous, if not identical, with physical and chemical phenomena. Whatever may be the final issue of this controversy between the two schools, it is undeniable that biological phenomena have as a matter of fact ever increasingly admitted of mechanical explanation in physico-chemical terms. All the most striking advances in biological science in recent years, have been achieved only along such lines. I do not, however, wish to be misunderstood as claiming that this fact by itself settles the ultimate dispute between the mechanistic and the vitalistic interpretations of life. I am fully aware, that, the vitalistic position may be restated, so as to take note of this fact. But whichever view is taken, relativity comes in with startling implications, compelling us to reconsider our respective points of view and fundamental categories. If the concept of physical force has been undermined by relativity, what is to become of vital force? If on the other hand, the mechanistic view is taken we find that relativity has radically altered the basic conceptions of dynamics and mechanics.

Let us turn now to another biological controversy concerning heredity and development which has engaged the attention of some of the most brilliant biologists and other thinkers from very ancient times. I refer to the rival theories of pan genesis and epi-genesis. The course of this controversy is one of the most fascinating episodes in the entire history of scientific speculation. Hippocrates, the father of medicine and the creator of the science of anatomy, was the first to enunciate the theory of pan-genesis. He thought that the contribution of the parent to the offspring is derived from the whole body of the parent. Aristotle rejected this view and enunciated his theory of epi-genesis, according to which, the parts of the young animal are not formed in the germ but are produced successively like the meshes of a net. Galen, the celebrated physician of Pergamus, revived, in the middle ages, the hypothesis of pan-genesis on more or less the same lines as Hippocrates. In the 17th century, Harvey revived the Aristotelian doctrine of epi-genesis and regarded the development of an animal as the successive differentiation of a relatively homogeneous germ. In the latter half of the 17th century, Harvey's hypothesis was controverted, on the ground of direct observation by Malpighi, who affirmed that the body of the chick is to be seen in the egg and in development no addition of new parts occurs, but a gradual unfolding of the

organs which already exist, though they are too small to be observed. The view of Malpighi was endorsed by Leibnitz on philosophical grounds, as it supported his "hypothesis of monads," and was adopted and extended by Haller and Bonnet, on the grounds of new experiment and observation. Though Wolff had refuted the view, and revived epi-genesis as early as 1759, the influence of Haller prevailed throughout the whole of the 18th century and eminent biologists like Cuvier and Buffon were more or less of the same view. The "*molecules organiques*" of Buffon are physical equivalents of the monads of Leibnitz. In the first half of the 18th century, with the foundation of the modern science of embryology, the doctrine of pan-genesis of Haller was set aside as incompatible with actually observed facts of development. But in 1869 the fortunes of the two doctrines were again reversed when Darwin in his "provisional hypothesis of pan-genesis" restored that doctrine and restated it as a result of numerous observations. Darwin assumed that every cell in the body at every stage of growth, and in maturity, is represented in each germ cell by a gemmule, that the germ cells are only the meeting place of gemmules, and the true reproductive power lies in the whole of the body cells, which despatch their representatives to the off-spring—hence pan-genesis. In the development of the embryo, the gemmules develop into cells and organs, similar to those from which they originally came. The laws of inheritance have been the subject of the most intensive study ever since. In 1874 the German anatomist His who founded the new science of experimental embryology enunciated specific organ forming regions in the apparently undifferentiated germ cell. Roux in 1888 by his experiments on frog's eggs, claimed to have proved the axiom of His, but Roux was attacked by Hertwig whose contention seemed to receive support from the remarkable experiments of Driesch on the eggs of sea urchin. He showed that each of the first two blastomeres when separated artificially from each other, had quite independently developed into a perfect larva of reduced size. Driesch, an avowed vitalist, held that the fate of a cell, was a function of its position in the embryo, not of its inborn specific quality or organ forming capacity. He asserted "the existence of an 'Entelechy' which out of the material at its disposal, constructed the organism which it knew and willed." The experiments and observation of Crampton and Wilson on molluscan eggs and those of many subsequent observers such as Conklin, Herlitzka and Loeb have since brought together a mass of experimental evidence in favour of the view that organ forming substances exist in the germ cells. As Prof. MacBride pointed out, we are being driven step by step to a position which seems to be in essential agreement with the underlying idea of the theory of pan-genesis as propounded by

Darwin. But the idea that adult organisms manufacture germ cells and transmit their characters to them in the shape of gemmules is now generally held to be erroneous.

The re-discovery of Mendel's Principles of Heredity has also shown the need to assume the existence of gemmules of inheritance-units in the germ cell.

Modern students of development regard neither of these extreme views as correct; adult parts are not contained in the germ nor is the latter homogeneous, but there are in germ cells undoubtedly many different structures unlike those of the adult which by transformation and differentiation, resulting from their combination and interaction with the environment, produce the complicated adult. In a sense, therefore, development is a creative synthesis; but then the same applies for instance, to the inorganic world, where also new substances and qualities are created, by a combination and interaction of chemical elements, which in themselves do not possess them.

The intensive study of the structure of the cell, the definite association of chromosomes with Mendelian characters, the practical isolation and continuance of germ-plasm, from generation to generation, have all shown that just as an entire organism even germ cells and all other kinds of cells are almost incredibly complex, a cell is a little microcosm or universe in itself. In other words we discover organisms to be systems of highly complex sub-systems which we call cells revealing unsuspected organisation. Is this an accidental product of natural selection or a purposive achievement?

Another phase of this very problem meets us in the great theory of organic evolution which has revolutionised the study of biology and has re-acted on world thought. Though the opposite view of special creation, has held its own till recent times and is even now being boomed by reactionary forces especially manifest in the so-called "fundamentalist movement" in the United States of America, the evolutionary view that all forms of life are capable of a perfectly naturalistic explanation as due to the growth and modification of primordial germs or even purely physical elements can also be traced back to very early times. Among the Pre-Aristotelian cosmologists, especially in Heraclitus and Empedocles, we find the evidences of abiogenesis and evolution. But it is in Aristotle who entered into the whole inheritance of Greek thought, that we find the most highly developed exposition of the evolution theory in classical antiquity. The Aristotelian doctrine of evolution is through and through teleological. In the many centuries that followed the golden age of Aristotle, narrow theological and other forces conspired to stress the elements of teleology to such an extent as to stifle the elements of scientific evolution, contained in the teachings of the great master. This reactionary tendency had reached such propor-

tions in the middle ages that the thinkers of the *Renaissance* like Bacon and Descartes had to raise the standard of revolt against a hasty and premature teleology and emphasize the importance of mechanical causes. Lord Bacon proclaimed in memorable words "final causes are barren like vestal virgins." It is true that, in Leibnitz, we find a reaction against this in favour of an enlightened teleology. Nevertheless, the trend of scientific development has been more and more in the direction of seeking for mechanical explanation of organic phenomena. Among pre-Darwinian biologists it is enough to mention the great French naturalist Lamarck, who fore-shadowed the modern theory of evolutionary concept. But the fundamental weakness of Lamarckian position lay in the awkward fact that with him theory far outran facts; also, his emphasis on the transmission of acquired characters has not found full support in the researches of later workers. It is the imperishable glory of Charles Darwin, even more than of Alfred Russel Wallace, to have furnished a formidable array of systematically arranged data in support of his causo-mechanical theory of evolution, such as has never been paralleled in the history of science before or since. The unique achievement of Darwin lay in the laborious establishment of his theory of evolution on a sound bed-rock of facts. This raised a storm of fierce controversy, in which his theory has been assailed from many standpoints. Though some of the weaker elements in his position have given way, and some others have had to be more or less modified, yet his central contention of the fact of organic evolution has become indisputably established. Darwin's immediate followers notably Haeckel, Huxley and Herbert Spencer, in their exposition of Darwinism, tended to lay undue stress on natural selection. August Weismann was perhaps the most original evolutionist since Darwin. He has not only disproved in the main the transmission of acquired characters, supposed by Lamarck as the chief cause of evolution, and the theory of pan-genesis expounded by Darwin, but has promulgated in place of Darwin's natural selection his theories of germinal selection and germplasm. In spite of the fact that the whole trend of scientific development has been tending towards the establishment of a causo-mechanical explanation of organic evolution, the rival theory of purposive selection, and teleology, still holds its own, and finds expression in the works of notable naturalists, like Dr. Hans Driesch and Johann Hjort of our own day. The issue between the two views may be stated as follows: What are we to make of the system and meaning and advance thus far discoverable in the trend of organic phenomena, which we call evolution? Is it intended, or have we come by it by a fortuitous concourse of circumstances? What difference will relativity make to this long-standing controversy?

To the relativist, only that is real which is perceived by all

observers. Experience shows that records, made by different observers in terms of the old Newtonian conception of space and time, involved irreconcilable inconsistencies. It is impossible to regard such records as true, until the reality, underlying them, which by definition must appear the same to all possible observers, has been recognised and expressed. "To deal in this way with records made by individual observers, is, to put them into the language of what may be called the universal observer."

"Individual observers are biased, by their states of motion relative to the things observed. To find out "truth" it is necessary to discover, what are the factors in those varying records which are common to all conceivable observers, or what transformation of the contents of the various records will produce such common factors."

The "Universal observer" picks out automatically these desired factors. He has eyes and fingers in all the corners of the universe and these eyes and fingers can assume every possible state of motion relatively to the things they are observing. To him the world is very different from that of any individual human observer's experience. It is a 4-dimensional world in which space and time play similar rôles."

To the universal observer, a human being is a sheaf of world lines. The four-dimensional world of Einstein is a static world with the events of the past, the present, and the future all definitely located in it. The relativist conceives of the whole universe as a static universe on which has been fixed or mapped out for all time the progress and procession of events. If so, the universe is a rigid mechanism, in which there is no room for any incalculable vital force, or possible choice, or variations of purpose. In so far as relativity does this, it seems to go against the teleological view, and to that extent it gives support, to the mechanistic view. But on the other hand in so far as it seems to make everything dependent on an universal observer's point of view, it contradicts the mechanist's position, and lends support to something akin to, if not identical with, the purposive intelligence for which the teleologists have contended in all ages.

What are we to make of all these ? Is the effect of relativity on biology absolute chaos and confusion ? It looks, as if, this were the greatest catastrophy that the biological science has ever faced, as it seems to threaten the very foundations on which it rests. But may it not be that this chaos and confusion is only apparent and transitory and not real or permanent ? May it not be due now as in other cases before, to the revelation of new truth, which for the time being seems to uproot long-standing ideas and prejudices and appears to destroy the very foundations on which we stand ? But the cloud is not without its silver lining. I, for one, seem to catch a glimpse of the

nature of the readjustment, to which the impact of the new doctrine of relativity on the biological science seems to point.

In conclusion, I shall endeavour to describe in a few words the nature of this glimpse that I have already referred to as the ultimate result of the application of relativity to organic phenomena. As biologists, we are aware of the fact, that the many differences which were originally assumed as separating the living from the non-living world, have been steadily disappearing, one after another with the advancement of science. We now know that many of the vital phenomena once considered mysterious are explicable in physio-chemical terms! More and more life phenomena are coming to be successfully interpreted in this fashion. We have seen that, several of the complex chemical products and constituents of organic life, are being now synthetically composed in our laboratories. We have discovered, that the elaborate structure or organisation long supposed to be peculiar to living matter is rivalled, by the no less wonderful and complex atomic structure of the inorganic world. Nor can we any longer regard the incessant self-initiated activity, as the peculiar prerogative of life, because it is also found in inorganic matter, as, for instance, the Brownian movements and the ceaseless revolutions of the electrons.

Apart from all this, it is of peculiar interest to us, that, in this very city of Calcutta, our illustrious countryman Sir Jagadish Chandra Bose, by his original researches, has supplied a further important link between the organic and the inorganic worlds. I refer to his great discovery that certain physiological characteristics such as exhaustion or fatigue is discernible in inanimate matter, such as a piece of lead. Last, but not least, relativity has now shown that shape, movement, age have probably no absolute significance or value; that system, plan and organisation characterise "point events" as much in the organic as in the inorganic worlds. This does not mean that all differences between the two spheres have been obliterated and that organic and inorganic matter are henceforth identical. There are still the most important characters of living things, viz., adaptive response to environment, and spontaneity of action, to be satisfactorily explained.

The greatest contribution perhaps that the theory of relativity has made to the conception, that the universe, whether organic or inorganic, whether animal or vegetable, is one composite entity, is its confutation of the fundamental concept of the conservation of energy as energy of physics, nay, of all science. Not long ago physicists, believed that mass or the quantity of matter in a body was fixed and invariable. Also the first law of energy held that in all the transformation undergone by an isolated system, the total quantity of energy is neither increased nor diminished; in other words, while energy may change form, it is neither created nor annihilated.

The energy of the universe as apart from mass was, therefore, conceived to be ever constant. The discovery of radio activity and the structure of the atom as composed of a system of electrons which are apparently only 'unit' charges of electricity has led the physicists to the belief that there is perhaps one entity in the universe which may be mass or energy. This original belief in the conservation of energy alone as distinct from mass had to be abandoned. Relativity has further undermined the resolute belief in the conservation of energy.

One of the direct consequences of the discovery of the discontinuous structure of matter is the necessity to consider the inter-action of a very large number of molecular and atomic elements and even electrons in the smallest of physical or chemical phenomena. The investigations of Gibbs and Boltzmann have, therefore, radically modified the principle of Carnot or the second law of thermodynamics. The original belief in the absolute determinism of physico-chemical calculations and occurrences can only be predicted approximately by the calculus or probabilities, that is, the apparently inevitable exactness of physico-chemical events is due to the law of "large numbers." Physicists have, therefore, been compelled to recognize fluctuations in the inorganic as in the organic world and the belief in final or absolute determinism has had to be abandoned even in the so-called exact sciences.

When the study of life assumed the role of a science, it was considered a science only in so far as it explained, vital phenomena in physico-chemical terms, to all of which the basic principle of the conservation of energy and absolute determinism was held to apply. As we have seen, the science of biology has been developed on purely mechanistic and determinist lines. But the biological sciences have been accused of being inexact, if I may use that word, because most biological occurrences which happen, cannot be predicted in advance. Animals and plants react to stimuli, sometimes in one way sometimes in another; that is, they act in unpredictable ways. This is true, in spite of the fact that the majority of our actions are not truly free, as they are the result of inclinations, habits, conventions and innate tendencies, transmitted by Heredity and the limitations imposed by material conditions. Inanimate occurrences on the other hand, are always more or less determined and are predictable. It is true that physical determinism has been shown increasingly to extend to such phenomena as Tropisms, reflexes, etc.; but there is undoubted indetermination or spontaneity of behaviour especially in all higher forms of life. Even if we accept the dogmatic assumption of the mechanistic school that spontaneity exhibited by life is only apparent and that it must be determined and that we could prove this as soon as we know all the facts and forces at work, the determinist is still at a loss to explain per-

ception, memory, choice and a host of vital phenomena, such as intelligence, pain, pleasure, etc. Life is mind, feeling, memory, emotion, pleasure, pain and so on to the vast majority of men and women and we cannot very well leave these out of account. If we are compelled to recognise that mind, etc., are to count in our speculations, what becomes of determinism and prediction which goes with determinism in biology. They are undoubtedly existences that are not conserved or determined. If they were such, the physicist expects them to continue in some other form after they have disappeared, and to be capable of being measured or weighed. But these vital phenomena seem to arise out of nothing and disappear into nothing. Hence the materialistic scientist has not so far believed in such phenomena as absolute realities. To him they are not *real*, for they are not conserved or determined. They are incompatible with the fundamental assumption of science that all energy is conserved and occurrences are determined. They are subjective and not objective entities. But to call them purely subjective does not dispose of them. In the present state of our knowledge—I refer to the theory of relativity—the physicist, no less than the biologist is not quite clear as to what is subjective and what is objective. What then are we to make of these entities and existences? Relativity has shown that energy even in the physical universe is not conserved, that mass and energy are interchangeable and could appear or disappear in either of these forms. While the whole trend of physical science during the last 100 years has been in the direction of proving that events in the physical universe also are not strictly determined. And thus the physico-chemical determinism that has characterised scientific thought from its inception has been attacked in its very citadel. Energy therefore is no more conserved and occurrences no more determined in the physical world of inanimate objects than in the biological world of living things. If so, the hitherto inexplicable but nevertheless real, biological phenomena seem to find a place in the general scheme of things.

We seem, therefore, to be gradually led ,step by step, to the view that both living and non-living things are far more intimately related than ever suspected before and form a coherent whole or unity. The universe, therefore, is appreciably one composite whole, and relativity, by the very methods of the most exact of sciences, would seem to have knit together the aims, methods and concepts of all the sciences on the one hand and even of philosophy and metaphysics on the other.

Section of Zoology.

Abstracts.

1. Observation on the incubation of the eggs and the development of the embryo of *Calotes versicolor* Boulenger.

J. J. ASANA, Ahmedabad.

The writer has been making observations for the last three years on the egg-laying habits and the eggs of *Calotes* both amidst natural conditions in the field and in the laboratory, with a view to obtaining closely graded embryonic stages for the study of the germ cell descent and embryonic development.

The eggs are laid in moist sandy earth, about 5 to 7 inches deep, in clutches of 13 to 20 eggs, which are separate and not glued together. The egg-laying period commences about the middle or third week of June, and lasts till about the end of August or first week of September. In the majority of cases the eggs were collected soon after being laid, after a period varying from 1 to 48 hours, and kept in moist earth at room-temperature exposed to ordinary diffuse sunlight, the earth being kept moist by sprinkling water on it at intervals. Two gravid females kept in confinement in the laboratory for about 8 to 10 days had their abdomen cut open; almost fully matured, shelled eggs were taken out from the oviducts and kept in moist earth under laboratory conditions for incubation. They were found to behave as ordinary naturally laid eggs. Successive stages of the developing embryo were collected and carefully fixed and preserved.

The fully laid egg is ovoid in shape, one end slightly pointed and is about 10 to 11 mm. in longer diameter and about 4 to 5 mm. in its shorter diameter. After about 24 hours' growth it has increased about 2 mm. in both directions. It shows very rapid growth from the 4th to the 5th day onwards till about the 16th to 18th day of its incubation, measuring roughly 2 cm. and 1·3 cm. in its longer and shorter diameter respectively, just before the young lizard is hatched.

Under laboratory conditions the young ones came out of the eggs after a period of development lasting over 43 to 46 days from the time of laying.

2. A preliminary note on the spermatogenesis of *Poecilocera picta* Fabr., Sub-family Pyrgomorphinae, Orthoptera.

J. J. ASANA, Ahmedabad.

Both male and female specimens of *P. picta* are found in fairly large numbers on *Calotropis* and on *Euphorbia* hedge from the middle of June to late in November. They are not difficult to keep and though no attempt has been made to breed them under laboratory conditions, they freely copulate and females were found laying eggs in the cage. Nymphs in the late instar stages have been collected from the field late in June and the beginning of July since 1925. Males are comparatively smaller in size than the females. Gonads are easy to dissect and could be passed into fixatives in less than half a minute. Several fixatives used in modern cytological technique both for the study of the nucleus and the cytoplas-

mic inclusions were attempted. Flemming with and without acetic, dilute Bouin, and Da Fano have been found to be more successful so far. Original method of Mann-Kopsch, Ludford's modification and Kotatchev have been given a few trials but with little success.

The male germ cells are of fairly large size and offer an exceptional opportunity for a study of the prophases on the lines indicated by Dr McClung in his recent paper on Synapsis in Mecostethus in the Journ. of Morph. and Physiol., Vol. 43, No. 2. In the auxocytes the "diatene," "peritene," "phanerosome," "cryptosome" stages in synapsis, preceding diakinesis could be clearly made out. At the completion of diakinesis, nine bivalents and one large unpaired, slightly bent, rod-shaped, accessory chromosome are seen on the equatorial plate ready for the reduction division. Polar views of the late anaphase in the reducing division show nine V-shaped chromosomes at one pole and nine V-shaped chromosomes with the single rod shaped accessory chromosome at the other pole. The succeeding division is equational and quickly follows the almost transitory telophase of the preceding reduction division.

The bivalents show distinctive chromosome sizes and shapes, the seriation being one large, two slightly smaller, five intermediate and one small bivalents and one unpaired, univalent sex-chromosome. The accessory or sex-chromosome shows a very characteristic behaviour, varying its size and shape, throughout the early auxocyte prophases.

The process of spermatid formation is of comparatively long duration, and from the study of the "nebenkern" one may infer that here one witnesses spermeteleosis of a primitive nature.

3. On the anatomy of the stomach in *Paludomus tanjorensis*.

R. V. Seshaiya, Tirupati.

1. The stomach of *Paludomus* is of interest due to the possession of a crystalline style. 2. The crystalline style is lodged in an anterior chamber of the stomach. 3. The style sac is separated from the intestine but the opening of the style sac into the stomach communicates by a slit with the portion of the stomach into which the intestine opens. 4. This condition is a transition very nearly approaching the one in which there is perfect separation between the style sac and the intestine. 5. A ciliated groove is present in the style sac and it is the abbreviated continuation of the communication between the opening of the style sac and the intestinal region of the stomach. 6. The style sac epithelium has the usual structure. 7. The style is probably secreted by the ciliated groove and is held at its anterior end within the circular termination of the ciliated groove. 8. A gastric shield is present and cuticle is developed on the epithelial walls in the region of gastric shield. 9. In connection with the gastric shield special folds of the ventral wall of the stomach are developed. 10. Glandular folds are present.

4. *Ceratium* in plankton off Calicut.

S. T. Moses.

Ceratium, with other Dinoflagellates, Flagellates and Diatoms, the food of the oil-sardine, a plankton feeder. Analysis showing the relative abundance or otherwise of *Ceratium* during 6 years from November, 1921. The Calicut species (1) *Euceratium tripos*, (2) *E. breve*, (3) *E. trichoceras*, (4) *E. massiliense*, (5) *E. vultur*, (6) *Biceratium lineatum*, (7) *B. furca typica*, (8) *B. f. engramma*, and (9) *Triceratium fusus*. The Phosphorescent species.

5. On the behaviour of Golgi apparatus in the oogenesis of *Calotes versicolor* Boulenger.

S. K. Dutta *and* J. J. Asana, Ahmedabad.

This paper attempts only to give a preliminary account of certain cytoplasmic inclusions in the oogenesis of the common Indian lizard, *Calotes versicolor*.

The ovaries of *Calotes versicolor* were fixed by various methods of modern cytological technique, of which only two, DaFano's Cobalt Nitrate method and Ludford's latest modification of the Osmic method, gave us the desired results.

In the young oocyte the Golgi bodies appear as a complex dense mass in the usual juxtanuclear position and consist mainly of granules.

In the later stages, the Golgi bodies become scattered in the cytoplasm and gradually become ultramicroscopic in the medullary region. Comparatively bigger Golgi spherules arrange themselves in a ring as a cortical layer. Subsequently, with the development of the egg they are broken up and lost to view in the general cytoplasm. At a particular stage of development, the follicular epithelium becomes very active and a large number of Golgi spherules appear to be extruded from the epithelial cells into the egg. They pass through the zona radiata and settle down in the extreme peripheral region of the egg where they are indistinguishable from the original Golgi spherules of the developing oocyte.

The Golgi bodies either directly or indirectly contribute to the formation of yolk.

The mitochondria, which are visible in Ludford slides stained by Champy-Kuhl technique, are probably responsible for the formation of true yolk.

6. On the habits of *Stegodyphus sarasinorum* Karsch.

P. M. Somasundaran, Bangalore.

Some glimpses into the social life of this gregarious spider, the constitution of a community, nest and web building, capture of prey and method of feeding, relation of the sexes, eggs and cocoons, parental care.

7. Note on the function of the mitochondria in some soil protozoa.

H. S. Madhava Rao, Bangalore.

Various species of protozoa occurring in soils have been isolated and grown in pure culture. Organisms at different stages of the life history were obtained and stained by means of the sodium salt of diethyl-safranine-monocarboxylic acid which stains the mitochondria only. The latter appear to be true cytoplasmic bodies and digestive in function, increasing in number by binary fission.

8. Preliminary note on the protozoa from some Mysore soils.

H. S. Madhava Rao *and* Roland V. Norris, Bangalore.

Typical soils of the Mysore area have been examined for their protozoal content and a study of the organisms isolated has been made. Three species apparently not previously described have been noted.

9. Two Acanthocephalous worms from Indian fishes.

S. C. VERMA *and* M. N. DATTA, Allahabad.

The senior author, in the course of his investigation on the Trematode and Cestode parasites of Indian food fishes came across some thin, cylindrical, elongated Acanthocephala in the pyloric caeca and small intestine of a species of *Ophiocephalus* at Mainpuri, U.P., in the summer of 1926; more specimens were subsequently collected at Allahabad also. The worm is a new species of the genus *Quardrigyous* Van Cleave, 1923, and is described in this paper.

Numerous specimens of another species were obtained by the same author in June, 1927, and later by the second author from a species of *Macrones* at Calcutta. This species belongs to the genus *Neoechinorhynchus* and has got no hooks on the anterior part of the body. There are three rows of six hooks each on the proboscis. Description of the cement gland, testes, proboscis sheath, and body wall are given.

10. Some Tetraphyllid Cestodes from Indian fishes.

S. C. VERMA, Allahabad.

Introduction. Four new species of tetraphyllid cestodes are fully described. One of these belongs to the genus *Acanthobothrium* of the family Onchobothriidæ. The other three are referable to the family Ichthyotæniidæ, one falling under the genus *Ichthyotaenia*, and two under *Gangesia.*

The species '*Gangesia bengalensis,*' described by Southwell (1913) as '*Ophryocotyle bengalensis*' and more fully by Woodland (1924) as *Gangesia wallago,* is reconsidered, as the latter description is in several respects misleading owing to confusion by the author of two distinct forms occurring in the same host into one.

Mention is also made of an immature worm of the family Phyllobothriidæ from a fresh water Siluroid, the systematic position of which is still under inquiry, and a new host is recorded of the monozoan cestode *Amphilina paragonopora.*

Acanthobothrium semnovesiculum sp. nov. This species was obtained from the common skate *Trygon sephen* Day-*Hypolophus sephen* Chandler, caught from the rivers Ganges and Jumna at Allahabad. It has a conspicuous characteristic vesiculum seminalis which, apart from other features, at once marks it out from the known species of the genus. In addition to an account of its anatomy, affinities and diagnostic features, a key to the species of the genus (after Southwell) is given, modified to include the new form.

Ichthyotænia vitellaris sp. nov. This is a large tapeworm occurring in the intestine of *Bagarius yarrellii* Sykes, containing about 700 segments. It is characterised by a prominent cap-like apical organ, and the peculiar L-shaped vitellaria like that of *Proteocephalus perplexus* La Rue, 1914. Some interesting abnormalities are noted in connection with the ovary and the related ducts. The systematic position of the new species is indicated and its diagnosis given.

Gangesia pseudotropii sp. nov. This interesting cestode, remarkable in more ways than one, parasitises *Pseudotropius garua* Day. It has a rostellum bearing at its top an apical organ, fringed with a beautiful crown of large hooks, well adapted to serve as an efficient boring organ. This armed rostellum is an essential characteristic of the genus *Gangesia.* But its two-field distribution of testes with a tendency to coalesce anteriorly is a common Crepidobothrium (Ophiotænia) feature. Accepting the definition of the Woodlandian genus *Gangesia* as modified by Meggitt (1927) to include the two characters mentioned above, the species fits in within this genus. The addition of a sentence in the definition of the genus, relating to the occurrence of spines on the

body of these worms, is suggested. Another remarkable feature of this parasite is noticed, namely, the development of some embryos, at least, into a cysticercus or bladderworm stage while still within the uterus of detached ripe and gravid proglottids found free living in the hind gut of the host.

Gangesia agraensis. sp. nov. This species is met with in the intestine of *Wallago attu* (in various parts of the province of Agra) along with specimens of *Gangesia bengalensis.* It differs from the latter by its smaller size, by the shape, size, number and arrangement of the rostellar hooks and by the much larger number of testes in each segment.

Gangesia bengalensis Southwell, 1913. This species is reconsidered and the description given of it by Woodland 1924, is modified in some respects.

Diagnoses of the above three species are furnished and the key of the genus *Gangesia,* drawn up by Meggitt (1927) is revised to include the forms above described.

11. On cytoplasmic inclusions in the oogenesis of certain molluscs.

D. R. Bhattacharya *and* C. B. Mathur, Allahabad.

In very young oocytes, the Golgi apparatus is, as usual, juxtanuclear, and consists of a number of circular and crescent-shaped bodies imbedded, as it were, in the idiosome. These ring-like and crescent-shaped bodies have a sharp chromophilic rim and a central chromophobic substance. The Golgi bodies in the animals examined appear to give rise to fatty yolk. The mitochondria contribute towards the formation of true yolk spheres both directly and indirectly. The nucleolar extrusions do not apparently take any part in yolk formation.

12. The reproductive processes of *Pila globosa* (Swainson).

K. N. Bahl, Lucknow.

No observations have hitherto been published regarding the reproductive processes of any Ampullarid. Baini Prashad in his monograph on *Pila globosa* says that he has not been able to observe these phenomena.

Since *Pila* (*Ampullaria*) is studied as a type of the Gastropoda in almost all the Indian Universities, it is necessary to have as complete a knowledge as possible of this form and I therefore undertook to study its breeding habits. The following is a summary of my observations :—

(1) After a prolonged period of æstivation during dry months, *Pila* comes out at the onset of the rains and begins breeding forthwith.

(2) Copulation takes place in water or on the ground at the edge of a pond. It lasts for about three hours or more.

(3) The penis being a structure independent of the male generative aperture, the genital papilla acts as a miniature second penis and effects the transference of the spermatic fluid from the male pore to the base of the penis proper.

(4) Both the penis-sheath and the penis are inserted into the mantle-cavity of the female and the free end of the penis is inserted into the vagina. Impregnation is internal.

(5) Oviposition takes place within a day or two after copulation and the foot acts as a very efficient ovipositor.

(6) Eggs are laid on the ground in small hollows in large masses. Each egg-mass usually contains 200 to 300 eggs but I have come across some very large egg-masses containing 700 to 800 eggs.

(7) Each egg consists of a shell, a double shell-membrane, a thick

layer of opaque solid albumen, and a core of fluid albumen in which the embryo floats.

13. Distribution of some freshwater species of the families Belonidae and Hemirhamphidae.

B. PRASHAD, Calcutta.

The distribution of two species of the families Belonidae and Hemirhamphidae is discussed in detail, and the question of the origin of these freshwater species in distinct river-systems is considered. It is suggested that this occurrence of the same species in these disconnected water-systems can be accounted for by assuming that these fishes had adapted themselves to fresh water independently in these areas. Owing to the absence of the species in the intervening seas it is further suggested that they probably originated from marine ancestors independently in the different areas.

14. Studies on the Viviparidae.

B. PRASHAD, Calcutta.

Amongst the freshwater Gastropods the members of the family Viviparidae are of special interest in that they have a very peculiar and discontinuous distribution almost all over the World. Both the recent and fossil members of the family are discussed in detail and a sketch-map illustrating the distribution of the recent members of this family is exhibited. The methods of dispersal, the question of the origin and the relationships of the family are discussed in detail and it is concluded that the family probably had a polyphyletic origin.

15. A note on the aquatic molluscs of the Shan States, Burma.

H. SRINIVASA RAO, Calcutta.

A brief general account is given of the freshwater molluscs occurring in the Shan States with special reference to the types of environment common in the region. The geographical distribution of the Shan species, and their affinities to the mollusc fauna of adjacent territories, are discussed.

16. On the infiltration of Golgi bodies from the follicular epithelium to the egg.

D. R. BHATTACHARYA, R. S. DAS *and* S. K. DUTTA, Allahabad.

Bhattacharya in the tortoise and Brambell in the fowl, have already described the infiltration of either minute or large Golgi elements from the follicular epithelial cells to the periphery of the egg. These bodies either filter through small canalicular spaces in the Zona Radiata or are extruded as comparatively larger lumps from the follicular cells to the Zona Radiata and from thence to the extreme periphery of the egg. The latter method of the passage of Golgi bodies has been observed by the present authors to be taking place also in the toad, pigeons and several other birds, *Calotes* and various other reptiles. The process of infiltration or extrusion is confined to a particular stage in the development of the oocyte. The structure and possible functions of these Golgi bodies are also discussed.

17. A preliminary account of the cytoplasmic inclusions in the oogenesis of *Columba intermedia.*

RAM SARAN DAS, Allahabad.

This paper purports to give only a preliminary account of the oogenesis of *Columba intermedia* from the point of view of cytoplasmic inclusions.

The usual cytological fixatives were used with this difference that "the cold method" advocated by Parat was largely employed. This gave very satisfactory results.

The Golgi bodies acquire the usual juxtanuclear position in the early stages of development at one pole of the nucleus. Later on they take a perinuclear position and are soon replaced by a fatty yolk layer.

The Golgi bodies of the cells of the egg membranes at a particular stage seem to acquire unusual activity and travel through the Zona Radiata into the cortex of the egg. Here they arrange themselves into a dust-like cortical layer of extremely minute granules. What further part they play in the development of the egg is uncertain.

Mitochondria in the early stages form a cap-like dense cloud over one pole of the nucleus. Subsequently they become distributed throughout the cytoplasm. In older oocytes a peripheral zone of mitochondria becomes noticeable.

In very young oocytes fat droplets or yolk become a characteristic feature of the developing oocytes. The perinuclear layer of the Golgi bodies is soon replaced by the fatty yolk which appears to have started formation even when the Golgi apparatus lies in the region which is generally designated as the yolk-nucleus of Balbiani or the dense protoplasmic area adjacent to the nucleus. There seems little doubt that the Golgi bodies become directly or indirectly converted into fatty yolk or what others call fatty vacuoles or droplets.

True yolk appears to be formed by the direct metamorphosis of mitochondria inside a vacuole. Neither nucleus nor cytoplasm appears to take a direct part in the formation of the true yolk bodies.

18. Cytoplasmic inclusions in the oogenesis of *Bufo melanostictus, Rana tigrina* and *Rhacophorus fergusonii.*

DHARAM NARAIN, Allahabad.

The Golgi bodies are noticed in very young oocytes in the usual juxtanuclear position at one pole of the nucleus. Later they begin to spread out and take a perinuclear position from where they disperse in the general cytoplasm and form fatty yolk.

In older oocytes a definite layer of dust-like golgi bodies is found in the cortical region near the Zona Radiata. There is evidence to believe that these bodies migrate from the follicular epithelium.

In the early stages, the mitochondria form a cap-like dense cloud over one pole of the nucleus. Later they disperse and become distributed throughout the cytoplasm. Only spherical mitochondria could be detected.

True yolk is probably formed by the metamorphosis of mitochondria. Neither nucleus nor cytoplasm appears to take a direct part in the formation of true yolk-bodies.

Very minute spherical fragments are extruded from the nucleus on all sides. They lose their colourability and are lost in the general cytoplasm.

19. Report on a collection of Ants in the Indian Museum.

DURGADAS MUKERJEE, Calcutta.

The report is based upon a collection of ants consisting of 40 species representing different sub-families. The majority of species recorded here come from the Himalayas, a few from the Palni Hills, South India, Seistan, and the rest from Calcutta. The report includes descriptions of five new species and brief notes on the habits of ants common in Calcutta and shows the altitudinal distribution of ants along the Himalayas. The collection was received through the courtesy of Lt.-Col. Seymour Sewell.

20. Notes on habits, structure and life history of an Indian Gordius worm.

DURGADAS MUKERJEE, Calcutta.

Several male and female Gordius worms were found wriggling on earth covered with rain water. The worms appear in the rainy season just after a heavy shower. They swim freely in water but generally intertwine with one another to form a tangled mass. They were kept in captivity and lived for a month. The captive females laid small strings of eggs. The eggs hatched after a month into minute larvae provided with an intestine and an introvert. The introvert contains minute spines at the base and its terminal end. The larvae were kept alive in water for a month and as the asexual stage is passed in the parasitic condition, an attempt was made to infect different animals with the larvae. The adult males have their posterior ends bifid, while the females are without any bifurcations or lobes at their posterior ends.

21. Observation on the course of the facial vein and the formation of the external jugular vein in common frogs and toads of Bengal.

J. L. BHADURI, Calcutta.

The facial vein in the frog, according to Gaupp, continues beyond the head as the cutaneous vein. But in *Bufo melanostictus*, the present author observes that the facial vein, instead of continuing as the cutaneous vein, curves round the angle of the jaw to open into the internal mandibular vein. He further notes that in *Rana tigrina* the facial vein, while continuing posteriorly as the cutaneous vein, sends off a branch round the angle of the jaw to open into the internal mandibular vein as in *Bufo*. In text books it is stated that the internal mandibular and the lingual veins unite to form the external jugular vein. But as seen in the present instances a common trunk formed by the union of mandibular and facial veins, unites with the lingual vein to form the external jugular vein. To distinguish this common trunk from the posterior portion of the mandibular vein the present author holds that the trunk should conveniently be called facio-mandibular vein.

22. Venous abnormalities in common frogs and toads of Bengal.

J. L. BHADURI, Calcutta.

The cases of abnormalities in the vascular system of frogs and toads dealt with in this paper have not yet been recorded in India. The author describes the following types of abnormalities which he came across during class demonstration.

(i) A peculiar venous ring girdling the carotid arch in a female toad.

The formation of the ring was due to the bifurcations of the right lingual vein and their union with the right external jugular vein.

(ii) Presence of several venous peculiarities in a single female toad.

(*a*) persistence of the left posterior cardinal vein.
(*b*) unusual thickness of the anterior abdominal vein.
(*c*) absence of post-caval vein,—two very large hepatic veins opening directly into the sinus venosus.
(*d*) a peculiar vein arising from the dorsal part of the oesophagus opening into the isthmus of the liver.

(iii) Truncated anterior abdominal vein in a female frog. The abdominal vein instead of opening into the liver terminates in a knob in the region of the liver. Nine cases of abnormalities in the anterior abdominal vein have been reported,—but no such knobbed condition has yet been recorded.

23. A case of hermaphroditism in *Rana tigrina.*

J. L. Bhaduri, Calcutta.

This frog externally exhibited the characteristic features of a male, while internally it showed a pair of thin convoluted oviducts and two small testes of equal size. Ovaries were apparently absent.

24. Note on a double Chick embryo.

J. L. Bhaduri, Calcutta.

A pair of chick embryos was found lying with their cephalic ends touching each other and their caudal ends diverging. Both the embryos showed normal features having their head regions divided into fore-brain, mid-brain and hind-brain, with well-developed optic vesicles, prominent notochord and primitive streak. The head regions of both were covered by a common proamniotic fold. Their general features were more or less similar but the numbers of segments in the two were different. The embryo on the left hand side contained 16 segments and the right 18. The occurrence of two such embryos in a single incubated egg at this stage is peculiar.

25. On the bionomics and structure of a new Trematode *Ommatobrephus lobatum* n. sp. from *Zamenis mucosus.*

H. R. Mehra, Allahabad.

Hitherto only one species of the genus *Ommatobrephus* has been described by Nicoll from *Uromastix acanthinurus.* The new species is a common parasite attached firmly by its huge ventral sucker to the walls of the rectum of the common rat snake.

A full account of the species and a discussion of the systematic position of the genus is given. The most important features are the unusual position of the testes near the hind end of the body and the precocious development of the miracidia. The latter were observed to come out of the genital opening and were carefully studied. The excretory system is aberrant from that of the family.

Two specimens belonging to a new variety were obtained from the rectum of a cobra.

26. On a new genus *Spinometra* belonging to the family Lepodermatidae from *Kachuga dhongoka*.

H. R. MEHRA, Allahabad.

The parasites are obtained from the small intestine and possess a very long protrusible cirrus. The genus does not show the phenomenon of amphitypy. Cirrus pouch is very large and contains a much coiled vesiculum seminalis. Genital pore is situated close in front of the ventral sucker to the left side. The oral sucker is very small, about one third in size of the ventral sucker.

The genus no doubt belongs to the sub-family Cymatocarpinae Baer, but it differs remarkably from all the genera in practically all the features of its anatomy which are described in detail.

27. A note on the life history of *Chonocephalus depressus* de Meiz—Fam. Phoridae (Diptera).

Rao Sahib Y. RAMACHANDRA RAO, Coimbatore.

Chonocephalus depressus de Meiz was described by Professor J. C. H. de Meizere of Netherlands Museum, Amsterdam, in 1912 from a female specimen from Medan (Sumatra). At Coimbatore this Phorid was found breeding in rotting fruit pulp in cages at the Insectary in 1913 and its life history was followed during the following year and notes taken on its various stages. While the females are wingless and resemble nymphs of Psocids, the males possess wings showing the typical neuration of Phorids. The males were observed to fly about carrying the wingless females in copulation. A description of the male form of *Ch. depressus* is given for the first time. The maggot is peculiar in possessing a retractile rat-tail like appendage at the hind extremity.

28. The life history of *Cyphocera varia*—a Tachinid parasite on *Spodoptera mauritia*.

S. RAMACHANDRAN, Madras.

This paper gives a detailed account of the life-history and habits of *Cyphocera varia*, an important Tachinid Fly parasitic on Caterpillars of *Spodoptera mauritia*. The fly has the very interesting habit of depositing its maggots on the trails of its host. These maggots wait at the spots, till one of the caterpillars happens to pass by them, when they attach themselves to it, bore into its body and feed there till pupation. The parasite with its highly specialised habits of reproduction is undoubtedly a great factor in controlling the recurrence of the pest in certain localities, for instances are on record where nearly 90% of the caterpillars and pupae collected had been parasitised by this fly.

Attempt is made in the paper to describe the development of the buccopharyngeal armature, and the posterior and anterior spiracles in the different stages of the maggot. Various other points connected with the life-history of the fly, such as the habits of the fly, its longevity, methods of larviposition, reproductive capacity, power of endurance of the maggots, etc., have been worked out.

29. A short note on a novel pest of tobacco—*Stibaropus tabulatus* Sch.

P. N. KRISHNA AYYAR.

Stibaropus tabulatus Schiodte is a Pentatomid bug which was observed to have the singular habit of attacking the roots of tobacco in a village in Coimbatore District. Though the insect was noted only in

one garden, the extent of damage done was not inconsiderable. The curious habits of this Pentatomid are described and an account of its life history given as far as could be worked out. Application of crude oil emulsion in varying proportions was tried and promising results were obtained by its application at a certain strength.

30. Hermaphrodite organs of Indian leech.

M. L. BHATIA, Lucknow.

Male organs:—

There are eleven pairs of testes segmentally arranged from the 12th to the 22nd somites connected with the vasa deferentia of the corresponding side. In front of the first pair of the testes, *i.e.*, in segment 11 the vasa deferentia continue their normal course, but in segment 10 they increase in width and form complex coils, the epididymis. From the inner side of each a short ejaculatory duct opens at the base of the penis, which is an eversible globular organ lying in segment tenth.

Female organs:—

The female organs lie entirely in the eleventh segment. The ovaries are a pair of minute filamentous bodies enclosed in small sacs lying close to the mid-ventral line and continued into short oviducts, the left oviduct passing under the nerve cord. The vagina is an elongated sac-like structure, expanded at the base but narrow at its distal end which opens to the exterior between the 2nd and 3rd annuli of segment eleven, *i.e.*, between rings 35 and 36.

The variations from the condition in *Hirudo medicinalis* are detailed in the paper.

31. Copulation in the common Indian leech.

M. L. BHATIA, Lucknow.

Leeches are hermaphrodite, each individual possessing two complete systems of generative organs one subservient to impregnation, the other to the production of ova. These animals, however, are not self-impregnating and union of the two individuals is essential for fertilization.

Two worms become attached to each other in a head to tail position in such a way that the annuli 30–31 of one, where the male aperture is situated, are apposed to annuli 35–36 of the other (the position of female aperture) and *vice versa*.

In this condition there is mutual exchange of seminal fluid which issues from the male aperture and is conveyed to the vagina by a tubular and eversible penis. After the exchange of the seminal fluid, the two worms separate.

32. Cocoon formation of *Hirudinaria granulosa*.

M. L. BHATIA, Lucknow.

The area of the body between 30th and 26th annuli is concerned in the formation of the cocoon. This portion of the animal may be called the clitellar region, though a permanent clitellum, as we find it in earthworms, is never present. During the cocoon formation a white frothy girdle appears round these annuli, no doubt formed from the secretion of the epidermal glands in that region. The ova are ejected through the female aperture and the animal slowly withdraws its head through the froth by the rhythmic contractions of the body. When the head is completely withdrawn, the openings at the anterior and posterior ends of the cocoon soon close up. The process of cocoon laying lasts for about five to six hours. In about 24 hours the froth hardens, becomes brown and the cocoon assumes an oval shape, measuring 15 to 30 mm. in length.

The wall of the cocoon consists of an inner membranous layer and an outer spongy layer enclosing the air bubbles, which make the cocoon float in water.

33. Notes on the blood vascular system of *Uromastix hardwickii.*

M. L. BHATIA, Lucknow.

The external appearance of the heart of *Uromastix* is typically reptilian, consisting of a sinus venosus, two auricles, and a single ventricle. The valve guarding the auriculo-ventricular apertures is a membranous fold strengthened by fibrous tissue, giving the shape of two hoods and resembles very much a pocket valve. Arising from the ventricle are three aortic arches (pulmonary, left and right systemics). All these arches indicate a slight twist and cross each other at the point of their origin. Each of the three trunks is independently guarded by a pair of semilunar valves. Right systemic opens first into the ventricle at a place where the left systemic and the pulmonary are quite independent. The lumen of the left systemic becomes connected with the right systemic, then with the pulmonary ultimately opening into the ventricle. In the arterial system all the main branches supplying the alimentary canal arise separately from the dorsal aorta.

A detailed account of the venous and the arterial systems is also given.

34. Parasites of lac in Hyderabad and elsewhere.

S. MAHDIHASSAN, Hyderabad (Deccan).

A number of parasites have been reared from different varieties of lac. Some parasites are common while a few show specificity in the species they parasitise.

35. Some observations on the salt-water lakes near Calcutta.

B. CHOPRA, Calcutta.

A preliminary survey of the salt-water lakes near Calcutta was carried out in May, 1926. The lakes consist of vast stretches of shallow water connected with the Hugli, and have a bottom of soft ooze-like mud, in places more than two feet deep. The scarcity of species and a great abundance of individuals of each species is the most characteristic feature of the fauna of these lakes.

36. Preliminary observations on the Indawgyi Lake and its fauna.

B. CHOPRA, Calcutta.

The Indawgyi is the largest freshwater lake in Burma. In the dry season it is about 16 miles long and is over 6 miles broad near the south end. In places the lake is very deep, but near the north end it is shallow, the average depth there in the dry season being less than 12 feet. There are no floating islands in the lake, though large masses of weeds, etc., agglutinated together are seen floating about at the north end. The lake is connected through the Indaw river with the Irrawady system.

The physical features of the lake are briefly compared with those of the Inlé in S. Shan States and the Loktak in Assam.

The fauna of the lake is very rich, specially in fish and molluscs. Some species of fish grow to a very large size attaining a weight of well over 100 lbs. Another remarkable feature of the fish fauna is the presence in the lake of representatives of the families Tetraodontidae

and Syngnathidae. Fishes of these families are not so far known to occur in any other freshwater lake in India.

37. A note on fish-mortality in the Indawgyi Lake in Upper Burma.

B. Chopra *and* D. Mukerji, Calcutta.

The physical features of the Indawgyi lake are briefly described in the foregoing paper. In the months of December and January every year very large numbers of fish die in the southern part of the lake for reasons so far unknown. The phenomenon of this mortality is briefly reported on in this paper.

38. On a curious mode of development of the suprabranchial labyrinthiform accessory air-breathing apparatus in the climbing-Perch.

B. K. Das, Calcutta.

The air-breathing apparatus in the climbing-perch (*Anabas scandens*) consists of two parts, viz., an air-chamber situated on either side of the posterior region of the head in contact with the otic capsule, and a delicate shelly-labyrinthiform organ lodged inside the chamber. The air-chamber is derived from the dorsal outgrowth of the opercular cavity. It is lined internally by two or three layers of epithelial cells, richly provided with blood-capillaries,—mucous cells and vascular papillae (like those of *Clarias* and *Saccobranchus*) being absent; externally, however, the wall of the chamber is invested by a thin layer of connective tissue crossed over by a few muscular fibres. The air-chamber thus formed communicates both with the pharynx as well as the opercular cavity, and the passage of air is controlled by a valvular structure ('Tellerformiger Nebenorgan' of Wilh. Peters) derived from the dorsal surface of the first ceratobranchial.

Certain observations have been made on the development of the so-called labyrinthine organ.

The structure and the mode of development of this fish have also been compared with those of other Labyrinthicians.

39. Observations on the 'drowning experiences' of the Indian fresh-water fishes of the Family Ophiocephalidae. (To be experimentally demonstrated.)

B. K. Das, Calcutta.

The amphibious snake-headed fresh-water fishes or Ophiocephalids are generally inhabitants of foul water, and are known to come to the surface to breathe atmospheric air. At times they also come out of their natural element, "walk" and enjoy nocturnal peregrination, and are able to sustain life for at least 4 to 6 hours under perfectly dry conditions owing to the possession of accessory air-breathing organs. During very hot weather they get themselves buried in the mud.

If prevented from coming to the surface by exposing a perforated diaphragm across the water of the aquarium, these fishes become very much agitated, beat against the sides of the aquarium and try their utmost to force out the diaphragm with their snout, their aquatic mode of respiration slackens and they show very violent convulsive symptoms till at the end of an hour or so they get "drowned" or asphyxiated.

Different species also behave differently during the drowning-period, and this varies considerably with the kind of water used.

After partial drowning the fish can be again revived by artificial

respiration. Injury to any particular portion of the accessory air-breathing organ has a marked effect on the "drowning" of a fish.

40. On the blood-vascular system of a common Indian carp, Rohu (*Labeo rohita*).

P. SEN *and* B. K. DAS, Calcutta.

So far the anatomy of this common North-Indian Teleost has not been worked out. The authors intend to give a complete account of the mode of arrangement of the various systems of this fish with a view to suit the college curriculum, but have at present confined their attention to the vascularity in general. In this connection there are several interesting features as regards the structure of the heart, the disposition of the afferent and the efferent branchial vessels, the formation of the renal-portal and the hepatic-portal veins, the curious origin of the posterior cardinals, the anal fin-loop and the single jugular vein.

Blood-vessels to the gonads as well as to the gas-bladder are worthy of note.

The interesting modification of caudal circulation as distinguished from other carps, and the formation of the hypobranchial arteries deserve special mention.

41. On the growth of scales in the rainbow trout (*Salmo irideus*).

D. BHATIA, Ludhiana.

The number of circuli or concentric ridges on scales obtained from a particular area of a growing rainbow trout depends on the size (weight) of the fish irrespective of its age or length.

Specimens under experiment were fed throughout a summer, a winter and next spring. They do not show any formation of the so-called "periodic-rings" on their scales. All the circuli formed correspond to the summer type, and the so-called "winter rings" were not at all formed during winter. It proves therefore that food is the principal factor which controls the formation of the rings on scales.

The rings though not uniform in width show no correspondence to the seasonal variations of temperature. Broad rings may be formed in summer, and narrow rings in winter (when the fish is fed throughout the year). The broad or narrow rings do not form any bands, for they occur quite irregularly on the scales. Their formation probably depends on the periods of maximal or minimal growth, which again depends mostly on the periods when the fish takes more or less food. Therefore, the chief factor concerned in the formation of the broad or narrow "summer and winter rings" is the abundance or scarcity of food, and not the rise or fall of temperature.

42. On the growth of the muscle cells in the developing fish—*Salmo fario*.

D. BHATIA, Ludhiana.

In the first stages of the larval development, the yolk-sac remains attached to the embryo, and the growth of the latter takes place at the expense of the yolk absorbed. The muscle cells simply undergo an increase in size. This growth is relatively much more rapid than the growth of the whole embryo. No cell division seems to occur. The muscle cells already formed when the larva hatches simply increase in size. The growth of the embryo is therefore almost entirely dependent on the *growth* (enlargement) of the muscle cells.

But as soon as the larva begins feeding, and the yolk absorption

is diminished or finished, the development of the muscle tissue is brought about in two ways—cell growth and cell multiplication. With the beginning of the adult life of the brown-trout, there is an appreciable, though gradual, fall in the relative cell growth of the muscle cell, although the fish itself is growing quite rapidly to an enormous size, so that the cell growth cannot keep pace, as it were, with the body growth. This difference in the relative growths of the two is made good by the increase in the number of cells, which occurs in an increasing degree as the development proceeds. So that the muscle cells grow in size as well as more cells are formed, either by division of the pre-existing ones, or the proliferation of new cells. And gradually, the phenomenon of cell growth yields to the phenomenon of the cell-multiplication to account for the growth of the fish body. The appearance of muscle cells dividing amitotically becomes more and more common in the latter part of the development.

43. Comparative morphology and anatomy of the Bombay marine slugs (Onchidiidae).

P. R. Awati *and* K. R. Karandikar, Bombay.

A joint paper by the same authors on the systematic position of the Bombay marine slugs (Onchidiidae) was submitted to the last Indian Science Congress. The present paper is a continuation of the same.

This paper is split into two parts; the first part deals with morphology and anatomy and the second with embryology and bionomics of the three species belonging to two different genera, *Onchidium* and *Onchis*. Only the first part is submitted before the present Science Congress.

In this paper detailed anatomy and morphology of *Onchidium verruculatum* is described and is compared and contrasted with that of the other two species as far as the important features are concerned.

44. *Anthophora violacea* Lepel.

G. R. Dutt.

In his key to the different genera of the family Apidae (now treated as Super-family Apoidea), given on pp. 414-415 Fauna British India, Hymenoptera Vol. 1, the late Col. Bingham placed the genus *Anthophora* under bees possessing three cubital cells in the forewing and a six-jointed maxillary palpus. In *Anthophora violacea* it has been ascertained that the maxillary palpus has only five joints. This peculiarity naturally causes some confusion to the beginners who, following Col. Bingham's arrangement, place *Anthophora violacea* under *Melecta*, the only genus mentioned by Bingham with a five jointed maxillary palpus. Some suitable changes to amend the Key have been suggested.

45. Studies on sex identification in the larva of the lac insect *Tachardia lacca*; the external morphological and resinous developments in the larva till the adult male and female stage.

Pratap Singh Negi.

The paper deals with the external features and the form of the larva on the basis of which a just emerged male larva can be distinguished from a female one, the field test experiments connected with it, the development of the male and female larva from the first week of its establishment on the host plant till maturity and the external resinous developments marking the metamorphosis and the dynamics of growth in the winter (Kartiki) crop.

46. A few interesting points on the emergence of larvae, sex ratio and parthenogenesis in the Lac insect (*Tachardia lacca*).

PRATAP SINGH NEGI.

The larvae emerge out through a distinct birth pore and not through the anal orifice or ruptures in the skin of the adult female as hitherto believed by previous workers, an efficient muscular system is present in the female to regulate the emergence of larvae to some extent according to the changes in the weather during the period of emergence; sex ratio in the various brood Lac insects during the Kartiki (winter) and Baisakhi (summer) crop.

The Lac insect *T. lacca* can reproduce parthenogenetically like other Coccids if necessary and the larvae are quite virile.

47. *Eublemma amabilis* the greatest predator of the Lac insect.

M. P. MISRA.

The whole life history of the insect has been discussed briefly, special attention being given to the points untouched by Mr. Witts and other earlier workers; the egg laying habits, longevity of adult moths, description of egg, larva, male and female pupa and the external points of differences between the adult male and female, sex ratio in the winter and the summer crops, the percentage of damage done in the various brood lacs during the two crops, distribution, the habits, time of hibernation and the number of broods in a year.

48. *Bracon tachardiiae* and Lac insect, the supposed host.

S. N. GUPTA.

The paper deals with the full fed larva, pupa, the pupal periods, the differences of male and female pupae and adults, and the longevity of adults. Approximately two generations of *Bracon tachardiiae* occur in the Winter Crop. From the extensive examination of Lac insects, it is suspected that the Bracon is not parasitic on Lac insect, but on the *Eublemma* larvae, as the cocoons have always been found either associated with the dead *Eublemma* larvae or inside galleries made by the *Eublemma* larva, while feeding on lac.

49. A new parasitic ciliate Protozoon.

EKENDRANATH GHOSH.

The body of the ciliate is elongately ovate, somewhat flattened, being nearly or less than twice as long as broad. The anterior end is tapering and blunt. The posterior end is rounded. The peristome is small, anterior and somewhat triangular; it extends to one-fourth of the body length behind or so. The manonucleus is spherical, with a large chromative mass in the centre and is placed just in front of the middle of the body towards one side. The single contractile vaenole is posterior and terminal. 0·0875mm. × 0·0375mm. The ciliate may be named *Balantidium noxum*.

The ciliate has been found in large number in the foeces of the common monkey (*Macacus rhesus*).

Section of Botany.

President:—Prof. M. O. Parthasarathy Iyengar, M.A., L.T.

Presidential Address.

Algal Work in India.

I am highly thankful for the honour that has been done me in being asked to preside over the Botany Section this year. In this address, I desire to place before you a brief resumé of the work done on Indian Algæ so far. In summing up our knowledge of Indian Algæ in their various aspects, systematic, ecological, distributional and cytological, I find that, although some work has been done in these directions, a great deal more has yet to be done, and, in many places, the gaps in our knowledge are very wide. I shall attempt a brief survey of the several lines of advance that have been made in Algal work in other countries and then consider some of the lines of research that can be profitably undertaken on algæ in this country.

Historical.

The earliest work on algæ in India was done by Wight, Belanger, Royle, Griffith, and Braun. In 1834 a few sea-weeds from the coast of Hindustan and also from the Madras harbour were recorded by Wight (76). In 1836, Belanger (3), who was the Director of the Botanical gardens, Pondicherry, recorded many sea-weeds from South India, particularly from Cape Comorin. Royle (63) in 1839 refers to the occurrence of some snow algæ in the Himalayas and to some Lemaneaceae in the cold mountain torrents. He also refers to certain marine algæ as being found in Rottler's Herbarium from the neighbourhood of Tranquebar in South India. Griffith (37) has described and figured six Characeae from Upper India and one from Kabul. Braun (8) in 1849 described some Characeae from India. Harvey (79) made a collection of sea-weeds in Ceylon in 1853 and his collections are now preserved in the Trinity College, Dublin. In 1854, he (42) described three interesting Red Algæ from Ceylon. In 1858 H. J. Carter (15) published an account of fertilisation in *Eudorina elegans* found in some pools in Bombay. His is the first record of fertilisation in *Eudorina*. A number of other Volvocaceae and Flagellatae was also recorded by him from the same pools. In 1871 he (16) recorded a new species of *Ceratium* from the Naini Tal Lake, in Kumaon, which he named *C. kumaonse*. In 1855

Doctor Wallich who was then Field Surgeon of the British army in India, during intervals of military duty, found time to collect and observe a large number of the local Chlorophyceae. His collections were very extensive and very rich, especially in desmids. In 1860 he (69) published an excellent account of the Desmidiaceae of Lower Bengal. In 1865 Grunow (40) published an account of some diatoms and desmids from the Island of Banka, near Singapore.

Hobson (43) in 1863 published an account of some Indian desmids. In 1872 Martens (59) gave an account of some Burmese algæ. Zeller (77) in 1873 published an account of some algæ collected by S. Kurz in British Burma and Arracan. Dickie (24) in 1882 published an account of some Himalayan algæ. In 1886 Joshua (50) described some desmids from Burma. In the same year an account of some Afghanistan algæ was given by Schaarschmidt (64). It is interesting to know that the algæ described by him were all found by him sticking to old herbarium material of some aquatic phanerogams. The old dried up material of the algæ was soaked in water and the details of their structure were very carefully examined. Many new species too were described out of this material. This shows what one can do out of even the most unpromising of materials, if one is keenly interested. In 1888 Lagerheim (52) published an account of some Bengal desmids. In 1893 W. B. Turner (68) published an account of "The Freshwater algæ of East India." This publication added considerably to the existing knowledge of Indian algæ, particularly, the desmids. But unfortunately many new species were described by him on very insufficient grounds.

Cunnigham (21, 22, 23) between the years 1880 and 1887 published an account of *Cephaleuros* (*Mycoidea*) attacking many plants in India. Between the years 1898 and 1907 Watt, Mann and Hutchinson (55, 56, 57, 71, 72) published several papers on the Red Rust (*Cephaleuros virescens*) of Tea.

West, W. & G. S. (73, 74, 75) published in the years 1897, 1902 and 1907 three important papers (1) on some algæ from Singapore, (2) on the Algæ of Ceylon and (3) on the Algæ of Burma, Bengal and Madras respectively. Fritsch (26, 27) published in 1907 two very valuable papers on the ecology of the freshwater and sub-aerial algal flora (1) of Ceylon and (2) of the Tropics as a whole.

Svedelius stayed in Ceylon for nearly a whole year (November 1902 to August 1903) and studied the marine algæ of the island. He published in 1906 (65) an account of the algal vegetation of the coral reefs of Ceylon with special reference to their periodicity and an account of the Ceylon Caulerpas (65) in 1907. Ghose in 1919 and the years following (28, 29, 30, 31, 32, 33, 34, 35) published several papers on the Myxophyceae of Lahore, Simla and Rangoon and a paper on a new species

of *Uronema* from India. Brühl and Biswas (4, 5, 6, 9, 10, 11, 12, 13) have published a series of papers during the last few years on the Algæ of Bengal, the Manipur State and the Barkuda Island in the Chilka Lake. The writer (44, 45, 46, 47, 48, 49) has published a few papers on the freshwater algæ of South India and a preliminary note on the sea-weeds of the Krusadai Island in the Gulf of Mannaar.

Crow (18, 19, 20) in 1923 published three papers on Ceylon Algæ. Groves (38, 39) published an account of the Charophyta of Ceylon and of India in 1922 and 1924 respectively. Allen (1) in 1925 published an account of some Characeae from Gonda.

Last year Dr. N. Carter (17) published an account of the Indian fresh-water algæ in the Records of the Indian Botanical Survey. Handa (41) published this year a paper on the sub-aerial Zygnemales of Rangoon.

A complete list of all the works on Indian Algæ, as far as I am able to gather, is appended herewith.

Systematic.

Almost all the several families of the fresh water algæ have been collected in India, the largest number of species described being under the Desmidiaceae. A large number of diatoms, too, has been described. But some families have so far received no attention whatever. For instance, very few Peridineae have been recorded from India. The only record so far was by H. J. Carter (16) of a species of *Ceratium* (*Ceratium kumaonse*), from the Naini Tal Lake in Kumaon. He refers also to the sea round the Bombay coast being coloured red through the presence of Peridineae in large numbers in the water. I have often come across stray individuals of this very interesting group in the waters of Madras. Last year I received a collection of a *Ceratium* from Bengal. It would appear that the water was simply teeming with these organisms and was coloured brownish consequently.

Another group which has not received any attention, but which occurs in large numbers in Indian waters, is the Flagellatae. This group of late years is receiving much attention from algologists in other countries. And the view is coming to be held on all hands that the Flagellatae cannot be completely separated from the algæ. On this point Fritsch (93) says, "It may be doubted whether at the present day the distinction between Flagellates and algæ is still a tenable one, since it is evident that there are a large number of phyla of pigmented Protophyta that, commencing with simple flagellate forms, have advanced to a more or less high stage of algal organisation."

The records of fresh water Rhodophyceae in India have been very meagre. Royle (63) refers to the Lemaneaceae

occurring in the mountain torrents of the Himalayas. West, W. and G. S. have recorded *Batrachospermum angolense* from Ceylon. In 1908 Prain (69) recorded *Compsopogon Hookeri* from Bengal. Brühl and Biswas have recorded two species of *Compsopogon* from the same province in 1924. Hooker recorded *Compsopogon* from Madras about sixty years ago. Thus the published records of Fresh-water Rhodophyceae have been so far very few. But I have during the last few years, received collections of *Batrachospermum* from Bengal and Mysore province and have myself collected it in Mysore, Travancore and the Pulneys. The above records suggest that the members of this group may occur pretty frequently in this country. I am sure that more records from various other localities in India can be made, if botanists will search for these interesting algæ in the cold mountain streams of the country, which are their favourite resorts.

Ecological.

With the exception of Fritsch's (26, 27) papers on the Ceylon algæ and on the algæ of the tropics, most of the publications on Indian algæ have been mainly systematic in character. Plenty of work on the algal ecology of India has yet to be done. Fritsch visited Ceylon in 1903, and made a brief stay there (Aug. 21—Nov. 10), studying the sub-aerial and fresh-water algæ of the island. He published a very valuable paper on the algal ecology of the island. This is the first, and so far, the only authoritative, account of the ecology of the Indian region. There are plenty of very valuable observations on the algæ of Ceylon in this paper. Every algalogist in India must study these two papers by Fritsch very thoroughly. Most of his generalisations on Ceylon algæ have been found by me to be equally true of the algæ of South India as well.

Phyto-plankton.

Much advance has been made in the ecology of fresh-water algæ in Europe and America. One of the chief branches of this work is the study of the phyto-plankton of inland waters, especially that of lakes. The algæ of a lake which grow near the shore region belong to the *Benthos*. A large number of tiny algæ are found floating in the body of the lake. These belong to the *Plankton*. The plankton algæ show special adaptations for floating in the water, such as the flattening of the body, the development of bristles and the secretion of mucilage—all of which tend to increase the body surface, and hence the floating capacity, of the algæ. These algæ reproduce freely in their floating condition. A few of the shore algæ may sometimes be found in the body of the lake, but they are not able to reproduce there, and so ultimately die out. These

forms are known as *Tychoplankton*. A few algæ however are found both in the middle of the lake and in the shore region and are able to reproduce in both the regions. Such forms are known as *Facultative Plankton*. The plankton algæ are usually collected by a fine silk net being drawn through the water behind a boat. The tiny algæ floating in the water are all caught by the net. But a few are so small that they pass easily through the meshes of the silk net. These can be obtained only by centrifuging the water which has passed through the net. Such forms as are able to pass through the plankton net are known as *Nannoplankton*. Plankton occurs in the bodies of rivers also and this is known as *Potamoplankton*. The plankton of smaller pieces of water is known as *Heleoplankton*. The term plankton was introduced in 1887 by Hensen. Among the other chief workers on the plankton must be mentioned Wesenberg-Lund, Bachmann, West, W. & G. S., Teiling, Pearsall, Smith, Strøm, Griffith, and others. The plankton flora of N. Europe has been divided by Teiling (90) into two groups, (i) the Caledonian type, in which desmids form a large proportion and (ii) the Baltic type, in which the Myxophyceae preponderate and desmids are very poor in number. West, W. & G. S. (94) from their experience of Scottish lakes stated that a correlation exists between the geological formation and the nature of the plankton flora. Lakes in the Carboniferous area are poor in desmids. Those in the secondary and tertiary geological formations are poorer still in desmids, but lakes situated in geological formations older than the carboniferous are very rich in desmids.

This hypothesis of geological correlation is not accepted by Wesenberg-Lund (92) who states that the richness of the desmid flora is due to the peaty character and the richness in humic acid of the water.

Murray (85) denies the geological theory and states that the factors deciding the growth of desmids are temperature and plenty of rainfall. Bachman (81) states that geological antiquity is of little importance and explains the occurrence of desmids as due to the chemical nature of the water draining from peaty swamps. He thinks that a careful chemical analysis of the water in which desmids occur will show certain compounds favouring the growth of desmids.

Pearsall (87) classifies lakes under two heads, (i) rocky and (ii) silted. The rocky ones favour a growth of desmids and Chlorophyceae, while the silted ones favour Diatoms and Myxophyceae. He thinks that the rocky lake plankton is primitive while the silted lake plankton is more evolved. He also considers that the rocky plankton flora is an open one, and that the silted plankton is a closed one. He supports the view of W. & G. S. West that desmids are most numerous on rocks of precarboniferous age. Desmid lakes according to him are poor in calcium

with a high proportion of potassium and sodium. The water is generally very clear and not peaty, with a neutral or a slightly alkaline reaction. Diatom lakes are rich in calcium, nitrates, silica and carbonates. Generally speaking, the desmid-rich lakes are remarkable for the clearness and purity of their waters and are very poor in organic contents. Pearsall thinks that this correlation between the chemical composition of the waters and the nature of the plankton occurring in it may have something to do with the metabolism of the algæ. The calcium-poor lakes have a phytoplankton largely composed of carbohydrate producing organisms such as desmids. In the calcium-rich waters, on the other hand, fat producing algæ (such as diatoms), are dominant. The Peridineae of the calcium-poor waters are chiefly starch producers, while those occurring in calcium-rich waters produce both starch and fat.

Smith (88, 89) working on the lakes of Wisconsin agrees with West, W. and G. S. in thinking that geological conditions are the prime factors in controlling the distribution of desmids. He thinks that the absence of lime may be the chief factor which favours the development of desmids, but does not understand why the blue green algæ should be absent. He does not accept the suggestion that temperature is the controlling factor, as lakes with similar temperatures, but chemically different, show differences in the blue green content. He suggests that the lack of nitrogenous compounds may be the factor, for when the water is contaminated by drainage from a settled area, there is a very considerable increase in the blue green content of the plankton.

It is often assumed that the plankton flora of a lake is derived from the immediate drainage basin of the lake and the swampy area around it. This view is not accepted as correct, as the organisms occurring in the lake plankton are highly specialised ones and are not found in the shore region. The source of the plankton algæ of a lake is some other neighbouring body of water which contains a true plankton flora. The migration of these algæ is brought about chiefly by aquatic birds, insects or air currents (89).

The plankton of fresh water reservoirs of town supplies is receiving much attention now in Europe and America. A large proportion of blue green algæ in the water gives a bad flavour to the water, which is not liked by the consumer. Again, as already mentioned, the contamination of the water by organic matter causes an increased growth of the blue green content of the water and often causes what is known as "water blooms." So the nature of the plankton is an indicator of the purity of the town water supply.

Plenty of work has been done on the fresh-water plankton of Europe and America. But practically no work has been done on the plankton algæ of India. The only work on Indian

plankton algæ is by Crow (20) on some plankton algæ collected by Fritsch in Ceylon. But in this paper no data regarding the environment are given. In India there are numerous artificial and natural lakes the plankton composition of which is certainly worth knowing. Much research is needed in this direction. Data regarding the geological formations of the lakes, the conditions of the water, the nature of the environment and the detailed composition of the plankton will throw considerable light not only on the plankton of India, but also on the plankton of tropics in general. The plankton of some of the African and Australian lakes have been investigated by West, W. and G. S. (95, 96). It would be interesting to know how far the plankton of the Indian lakes resemble them.

Periodicty of algæ.

Much work has been done on the periodicity of algæ by Fritsch and Rich, Hodgetts, Griffiths, Transeau, Delf and others. The factors controlling reproduction of algæ in nature have been receiving much attention. The idea which is got from laboratory experiments, that favourable conditions conduce to vegetative propagation and that the onset of adverse conditions induces sexual reproduction, is found to be not quite in accord with the phenomena observed in nature. It is found that sexual reproduction is not necessarily confined to the end of the season when the algæ are about to disappear, but occurs very often when there is plenty of water and the conditions for the life of the algæ are very favourable. According to Transeau (91) some of the algæ occur in early Spring, some in Summer, some in Autumn and some in Winter. He classifies the algæ under Spring annuals, Summer annuals, Autumn annuals and Winter annuals, according to the times of their dominance. He also found that many algæ pass through a good period of vegetative activity before they reproduce. The failure of many workers in their attempts to induce the reproduction of algæ under laboratory conditions is to a large measure due to their not taking into account the age of the algæ they are investigating. Our knowledge regarding the periodicity of Indian algæ is very meagre. Research in this direction is urgently needed.

Algal Succession.

Other problems connected with algal ecology are questions of algal succession in nature. There is a kind of algal succession which I have come across on the freshly white-washed walls of houses in Madras. The white-washing kills out most of the previous algal growth on the wall. After the heavy monsoon rains the first algal growth to appear on the newly white-washed wall is some green algæ, (*Protococcus, Sticho-*

coccus, *Protosiphon*, *Cylindrocystis*, etc.). When the rains cease and the weather becomes drier, the green algæ gradually disappear. During the monsoon season next year the green algæ again appear, but a good quantity of blue green algæ begins to grow along with the green algæ. In the next monsoon season again the blue green algæ practically occupy the whole area to the complete exclusion of the green algæ. Later on, if some soil should accumulate on the wall, as happens on very old walls, a species of Moss begins to grow and ultimately completely dominates the area. The blue green algæ may not totally disappear but a few may be found among the moss plants. This is only a single instance. And there is plenty of field for research in the algal succession of our pools, ponds, ditches, tanks, lakes, streams, rivers, rocks, tree trunks, moist soils, etc.

ALGAL ASSOCIATIONS.

The algal associations of different situations such as rain water pools, ponds, ditches, paddy fields, tanks, lakes, streams, rivers and various sub-aerial situations, such as, tree trunks, surface of leaves, rocks, walls, road cuttings and moist soil, have yet to be studied in detail.

Another line of work which is receiving much attention in other countries is the study of soil algæ. Plenty of work has been done with regard to the algæ of soils by Esmarch, Robbins, Peterson, Bristol and others. It has been found that the presence of blue green algæ is an important factor in the fixation of nitrogen by soil bacteria. It is considered that the bacteria derive their organic material from the mucilaginous investments of the blue green algæ, which are found most commonly in all soils. Bristol (83) says that the living algæ of the soil play a very important part in the economy of the soil. This line of work also offers plenty of scope for research in this country.

A word may be said about symbiotic algæ. *Anabæna azollæ* lives inside the slime filled hollows of Azolla. *Anabæna cycadearum* occurs in the coralliform roots of Cycas. In the case of the latter, the alga is associated with two nitrogen fixing bacteria, *Pseudomonas radicicola* and *Azotobacter*. It is now accepted that there is a symbiotic relationship between the alga and the bacteria. And the Cycad, it is believed, ultimately gets a certain amount of nitrogenous supply from this association. M. O. T. Iyenger found in *Lemna* in Madras an *Anabæna* associated with some bacteria. He made cultures of the bacteria and showed that the bacteria were able to fix the atmospheric nitrogen.

GEOGRAPHICAL DISTRIBUTION.

A study of the geographical distribution of the algæ occurring in India will prove to be immensely interesting. Most of

the algæ occurring in India are cosmopolitan. But some are confined to India or show a limited distribution within certain definite parts of the world. The distribution of desmids is particularly interesting. Desmids are not able to withstand desiccation. And they do not form spores or zygotes commonly Nor are they able to withstand immersion in salt water. So the chances of their distribution across wide ocean barriers are very small. And a careful study of the distribution of identical species or closely related species will throw much light on former land connections. Some records have been made on Indian algæ which are quite interesting. W. & G. S. West in their paper on Ceylon algæ (74) say that one striking feature is the presence in Ceylon of a large number of the same species as occur in Madagascar. There is a great resemblance between the algal flora of Ceylon and those of North Queensland. Desmids particularly exhibit geographical peculiarities and one may easily discriminate between definite Indo-Malayan types, African types, American types, Arctic types, and so on. Dr. N. Carter (17) states that the desmids of the plains and the lower elevations of India conform to the Indo-Malayan group while those of the higher elevations resemble the European forms. She has recently recorded from India (17) *Oocardium stratum* and *Debarya desmidioides*. The former has been known only from Europe and America and the latter only from Cornwall in England. And what is more interesting she found that the *Oocardium* was conjugating freely. The conjugation of this desmid has not been known before. I collected a species of *Ecballiocystis* from Tinnevelly District near Cape Comorin which closely resembles a species of *Ecballiocystis* described by Fritsch from South Africa. It is very interesting that these two very closely related species should be found in the southern extremities of Africa and India respectively. Another interesting find by me in Madras is *Tetrasporidium javanicum*. This alga has been recorded previously only in Java. *Physolinum monile* (De Wildem.) Printz (=*Trentepohlia monilia* De Wildem.), which has been previously recorded only from Java, South Africa and Chile has been found by me in Madras. Further researches in this country will throw much light on the distribution of other interesting algæ.

CYTOLOGICAL.

During recent years considerable work has been done on the cytology of algæ. I here propose to deal with the chromosome variations only of the green, brown and red algæ.

Pascher (86) has shown that the ordinary cell in *Chlamydomonas* is haploid while the zygote is diploid. The zygote nucleus divides twice and four daughter cells are formed. The first division is a reduction division.

In the Zygnemaceæ (*Spirogyra* and *Zygnema*) the plant proper is haploid and the diploid condition is seen only in the zygote. The zygote nucleus during germination divides twice forming four nuclei, the first division being meiotic. Of the four nuclei one persists and the other three degenerate and die, and the germinated filament has got one single haploid nucleus in each cell. The Desmidiaceæ resemble the Zygnemaceæ in their nuclear history. The zygote is the only diploid stage. The zygote nucleus during germination divides twice forming four nuclei, the first division being meiotic. Among the Mæsotæniaceæ, four daughter cells are formed in *Cylindrocystis* and two daughter cells in *Spirotænia*. In the Desmidiaceæ, the zygote divides into two protoplasts, each protoplast receiving two nuclei. Of these two nuclei, one degenerates and dies and the other remains normal. So the ordinary desmid cell is haploid, the only diploid stage being the zygote. In *Coleochæte* the fertilised egg cell is the only diploid stage. The plant proper being haploid. It was thought formerly that the group of cells formed by the division of the fertilised egg represented a diploid generation. But Allen has shown that the first division of the fertilised egg is meiotic.

In *Oedogonium*, *Bulbochæte* and *Hydrodictyon*, the fertilised egg cell divides into four zoospores. It is presumed that even here the first division may be meiotic. But actual observation of the reduction division is wanting in these cases.

Among the Diatoms, the plant in the Centriceæ is haploid, the diploid condition being found only in the zygote stage. The haploid condition is attained again by the reduction division of the zygote. In the Pennatæ, the plant is diploid and reduction division takes place when the gametes are formed. They resemble *Fucus* in this respect.

The cytology of *Codium tomentosum* has been recently worked out by May Williams (97) who showed that the plant is diploid while the gametes are haploid, the reduction division taking place in the gametangium.

Within recent years our knowledge concerning the cytology and reproductive processes of the Phæophyceæ has been considerably advanced through the works of Farmer, Lloyd Williams, Sauvageau, Yamanouchi, May Williams, Tahara, Knight and others. In *Pylaiella* there is a fluctuating alternation where the diploid phase may several times be repeated with a similarity of form in the two generations. In *Dictyota* there is an alternation of diploid and haploid (diœcious) generations, both the generations looking similar in external appearance. The reduction division takes place in the tetrasporangium. The cytology of *Padina pavonia* has been recently worked out by P. W. Carter (84). The plants are of two kinds, the sporophyte and the gametophyte. The gametophyte is monœcious. An alternation of generations has been shown to be present

in its life history. The reduction division takes place in the tetrasporangium as in Dictyota. In Cutleria, the two generations are very unlike, the sexual plants being erect and dichotomously branched, while the sporophyte (formerly considered to be a distinct plant known as Aglaozonia) being flat, lobed, prostrate and discoid. In Laminaria, the two generations are extremely dissimilar. The plant proper is the sporophyte, while the gametophyte is reduced to a very minute size. The sporophyte produces numerous club-shaped sporangia in which are formed the zoospores. Reduction division takes place in the sporangium. The zoospores give rise to the tiny gametophytes which are dioecious. In Fucus, the plant proper is diploid, the haploid stage being represented only by the gametes. There is much difference of opinion regarding Sargassum. One view is that there is no mitosis in the oogonium of Sargassum. This is now contradicted and it is stated that the usual eight nuclei are formed, although only one oosphere results. Another statement is that of the eight nuclei two remain functional. This requires confirmation.

Coming to the Rhodophyceae, our knowledge of the cytology of the group has been considerably enlarged through the valuable researches of Lewis, Kylin, Svedelius, Yamanouchi, Wolfe, Cleland, Davis and others. In types resembling Scinaia, reduction division takes place immediately after fertilisation; so the plant is haploid, the only diploid stage being the fertilised egg. In the case of Polysiphonia, Yamanouchi (98) has shown that there is a regular alternation between a diploid generation and a haploid (male or female) one, the two generations looking similar in external appearance. The reduction division takes place in the tetrasporangium as in Dictyota. Similar conditions have been shown to occur in Griffithsia, Delesseria, Nitophyllum and Rhodomela.

Last year Borgessen (82) described a very interesting species of Liagora, *Liagora tetrasporifera.* In this alga, the sporogenous filaments did not form any carpospores at all, but formed instead tetrasporangia at the ends of the filaments. Four tetraspores were formed in each tetrasporangium. The cytology of the alga has not been worked out; but he presumes that the sporogenous filaments are of a diploid nature and that the reduction division takes place in the tetrasporangium.

There is plenty of scope for research on the Cytology of the Chlorophyceae, Phaeophyceae and the Rhodophyceae of this country, as the algal flora of our country, both freshwater and marine, is so very rich.

TYPE SPECIMENS.

In other countries type specimens of plants are deposited in well known institutions for safe custody so as to be available

for future reference by other workers. Types of the Phanerogams, Ferns and the other bigger plants of the country are kept carefully in the herbarium of the Royal Botanic Gardens, Sibpore, Calcutta. Types of the Fungi collected in India are I believe carefully preserved in the Agricultural Research Institute, Pusa. Unfortunately there is no place where all the type collections of Indian Algæ are maintained. It is very essential that some institution should undertake to maintain a type collection of all the Indian Algæ from various localities.

EDUCATIONAL.

The syllabuses for the various examinations need standardisation regarding the types to be studied so far as the algal portions are concerned. We are still having plenty of european types included in our syallabuses though good substitutes are available in the country. The members of the Botany staff of the various Universities and Colleges in India might make out a list of the most suitable Indian types to be included in the syllabuses of all the institutions in India. The life histories of all the selected types must be carefully worked out and incorporated in a common text book of Botany for the whole of India.

To encourage research on the part of students it is highly essential that small hand-books should be published on the algæ of the different parts of the country with suitable keys for the identification of the several species with illustrations for each.

I have attempted to place before you the several lines of research on Algae that might be taken up by workers in India. I hope by this address I shall be able to induce many of our botanists to take up the study of Algæ and by their researches add considerably to the existing stock of knowledge regarding this very interesting group.

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Section of Botany.

Abstracts.

1. Some interesting observations regarding parasitism in Cuscuta and the nature of the stimuli causing the production of haustoria.

H. CHAUDHURI, Lahore.

Some interesting observations have been made regarding parasitism in Cuscuta. Cuscuta not only parasitises almost any host plant, it will suck nourishment from another part of its own body. Experiments regarding the stimulus or stimuli causing the production of haustoria in Cuscuta have been carried out and it has been found to be due to the joint stimuli of contact and strain due to twisting. Chemical stimulus seems to be absent. It has been found that Cuscuta is almost blind regarding its choice of host, provided it can break through the outer tissues.

2. Green-ear disease of Bajra (*Pennisetum typhoideum* Rich.).

H. CHAUDHURI, Lahore.

Though usually not of sufficient intensity to attract notice, this disease—which shows by a reversal to leafy structures of the floral parts—caused great loss to Bajra in certain parts (Dinga and other places) of the Punjab last winter. In certain fields which at least had not attracted attention before, over 80% of the crop was destroyed. The incidence of the epidemic could not be attributed to either bad drainage or special atmospheric conditions. In Lahore district only a few plants were found to be affected. Though search has been made in all stages of their growth, conidial stage has never been found. Young plants which showed whitening of the leaves in long streaks were kept under observation. When old, the tissues turn brown and tear along the streak and like the Sclerospora disease in Jowar, produce a large quantity of oospores immersed in the leaf. The leaves with the streak always harboured fungal mycelium. The plants which were badly affected never produced any ear but tufts of leaves instead. In other cases, part of the ear became transformed into twisted narrow leaves. Since in Lahore very badly diseased plants failed to infect other Bajra plants growing together, it seems unlikely that the fungus can pass from one to another host. Experiments regarding causes for fresh infections are being carried on.

3. *Cistanche tubulosa* on Salsola and Suaeda from Karachi —a study of their anatomical and physiological relationship.

H. CHAUDHURI, Lahore.

During early December, 1926, a large number of Cistanche plants with the two hosts were collected from the sands at Manora Island and Cliften Beach.

It was interesting to find how such a heavy succulent plant could sustain nourishment from such tiny woody hosts. Detailed anatomical investigations have been carried out. It is found that whenever a root is parasitised by Cistanche, it at once grows in girth. The growth takes

place by formation of rings of xylem vessels. The haustoria connect with the xylem and practically no phloem vessels are formed. The tuber consist mainly of water storing cells and as it remains embedded in the sand, practically no strengthening tissues are developed. The scale leaves which cover the whole surface of the tuber, are specially fitted to absorb water by their concave sides, and they readily absorb it. The water passes through the scale leaves into the storage cells of the tubers. Cistanche weighs generally 10 to 20 times more than its host plants. The parasite absorbs most of its necessary water by its scale leaves—other necessary materials being supplied by its host. To maintain the proper supply, the growth in girth mentioned before takes place and there is a general greater development of the root system of the host plant than the plants that are not parasitised.

4. Injection experiments with special reference to the production of alkaloids, etc., and general metabolism in plants.

S. Krishna *and* H. Chaudhuri, Lahore.

For experimental purposes two or more species of the same genus were taken at a time which differed in the production of alkaloids, etc.

The plants were all grown from seeds under observation. Successful and interesting results were obtained when even minute quantities of chemicals in colloidal solutions were injected. Thus when in Opium Poppy, which normally contained Berberine, colloidal iron was injected, it produced less quantity of that alkaloid, whereas in red poppy which contains practically no Morphine or Berberine, when colloidal iron was injected, Berberine was actually found. Injection of colloidal Sulphur caused vigorous growth and produced healthier flowers and seeds, though the flower production was a bit delayed.

Injection of colloidal iron, in a number of plants, inhibited the development of flower buds.

5. The structure and development of the sex organs in *Notothylas indica* Kashyap.

S. K. Pande, Lucknow.

Our present knowledge of *Notothylas indica* is confined to the structure of the thallus and mature sporophyte (Kashyap and Dutt: *Proc. Lahore Phil. Soc.* IV) and to the embryology (Pande: *Proc. 14th Ind. Sci. Congr.*, Lahore, 1927).

The author now describes the structure and development of the sex organs.

The ripe antheridia are orange red in colour and arise endogenously as in other anthocerotales. Generally 3 or 4 of these are found in a chamber; but as many as 6 may occasionally be met with.

The structure and development of the archegonium so far worked out agrees with the account given for the other species of Notothylas except that the number of the neck-canal cells in the mature archegonium of *N. indica* is 6.

6. A new species of Petalophyllum, *Petalophyllum indicum* Kashyap, from Lahore.

Shiv Ram Kashyap, Lahore.

Two species of Petalophyllum are described by Stephani but none is so far known from India. The present paper describes a new species from Lahore.

Plants simple or furcate growing singly or in patches, up to 12 mm. long and 7 mm. broad. Basal portion cylindrical and wingless. Dioecious. Antheridia in groups with scattered scales. Archegonia in groups of 4–7 on the midrib, protected by a bellshaped perianth with a lacerated margin. Pedicel 10-20 mm. long, occasionally very short, sometimes up to 25 mm. Capsule 2 mm. in diameter, spherical, wall usually 3 layered, outer layer thin walled, inner with annular or semiannular bands. Spores dark brown, about 40 *u* in diameter, reticulate lamellate. Elaters 3-spiral, 280-400 *u* long.

The apex becomes thickened and buried underground, forming a tuber.

Found by Pt. Bhagat Ram Vasisht, on the bank of the river Ravi in November, 1925. The plant grows in winter.

7. A curious abnormality in *Pellia calycina.*

SHIV RAM KASHYAP, Lahore.

Pellia calycina is an exceedingly common plant in the Himalayas, The specimen described in this note was found at Kosi, Almora district. on the 7th June, 1926.

The specimen is an oblong lobe of a thallus the other branches of which have been broken off. The abnormality consists in the fact that the lobe shows doubling like the doubling of the corolla in an angiospermous flower. In the anterior half of the lobe the wing on each side has divided horizontally up to the midrib. On the under side of the ventral wing a small shoot has again been given off on the right side. The dorsal wing also shows indications of the development of short adventitious shoots on its upper surface in two or three different places. The margins of both the dorsal and ventral wings are lobed resembling rudimentary leaves like those found, for example, in *Blasia.*

Such an abnormality has not been described so far in any liverwort. It not only brings *Pellia* nearer the leafy forms but also possibly throws some light on the origin of the dorsal wing or wings in Riella which character is otherwise so difficult to explain.

8. On some new and interesting forms of Pandorina, Eudorina and Pleodorina from Madras.

M. O. PARTHASARATHY IYENGAR, Madras.

During the last few years many collections of Volvocaceæ have been made by the author in Madras. Among these were found certain new forms of Pandorina, Eudorina and Pleodorina which have not been recorded before. A detailed account of these algæ is given and their relation to the previously recorded species is discussed.

9. Note on some species of Debarya from South India.

M. O. PARTHASARATHY IYENGAR, Madras.

Species of Debarya are generally of very rare occurrence. With the exception of one species recently recorded by Dr. Nellie Carter, there have been no records of Debarya from India so far.

Five species of Debarya have been collected by the author from different parts of South India, (Madras, Jog Falls in the Mysore State and Periyar in Travancore). A detailed account of these is given in the paper. One of the species collected at Jog Falls is very interesting in forming plenty of peculiarly thickened azygospores (parthenospores) in addition to zygospores by conjugation. The azygospores and zygospores are formed by the same filaments.

10. On a sub-aerial attached species of Mougeotia from Travancore.

M. O. Parthasarathy Iyengar, Madras.

This Mougeotia was found in Periyar (Travancore) growing on the vertical face of a rock-cutting over which water was very slowly oozing from above. The alga was attached to the substratum by well developed rhizoidal outgrowths from its cells. Plenty of lateral conjugation was seen in various stages. Scalariform conjugation also was seen here and there, but only very occasionally. This lateral conjugation would appear to be best suited to a form which has to lead an attached existence and, that in a sub-aerial habitat.

A fairly thick layer of mucus was found round the filaments and a good quantity of mucus was secreted round the zygospore during conjugation.

The secretion of mucus by the alga is a very useful adaptation for its life in a sub-aerial situation, since this mucus covering gives the necessary protection against sudden desiccation.

11. Studies on spore formation by yeasts.

V. Subrahmanyan.

The production of ascospores by certain of the representative yeasts on various liquid and solid media and in presence of a number of mineral salts has been studied. The factors determining the numbers of spores per cell, their individual shapes and sizes and their subsequent fermentative activity have been ascertained.

12. Somatic cell division in *Aloe vera* Linn.

R. N. Sutaria, Ahmedabad.

When 8 chromosomes are arranged on the equatorial plate of the bipolar spindle, some of them show a longitudinal split. In anaphase 8 large J-shaped chromosomes are seen at each pole. They fuse and form a deeply-stained compact mass. In the telophase, there is very little vacuolization of the chromosomes. The equatorial cell plate now completely divides the whole cell in two daughter cells.

The reconstructed daughter nuclei show one to three nucleoli. The nuclear reticulum is distributed at the periphery in contact with the nuclear membrane. The nucleolus is vacuolated and often shows crystal like bodies. Gradually a regular spireme appears with a distinct split here and there. The spireme then breaks up into broad thick bands which ultimately contract and form the chromosomes.

13. Nuclear division in the pollen mother-cells of *Aloe Vera* Linn.

R. N. Sutaria, Ahmedabad.

The resting nucleus of the pollen mother-cells shows a granular reticulum, with 1 to 4 nucleoli. The nuclear reticulum contracts and passes to one side of nucleus forming a typical synizesis stage. The nucleous grows rapidly and occupies an eccentric position in the cell. The balled up knot opens and the loops extend throughout the nuclear cavity and form the open spireme stage. The spireme is beaded in nature and seems to be uniform and continuous. No split is seen. In the brochonema stage, definite loops, corresponding to the number of haploid chromosomes, are found.

The bivalents are U or S-shaped and are made up of two end-to-end united univalents. Occasionally a split is seen in each univalent member of the bivalent. In heterotypic metaphase, the 4 bivalents arrange themselves on the equatorial plate of the bipolar spindle. In late anaphase, the univalents are V-shaped. In telophase, each pole shows a compact mass of fused chromosomes.

After interkinesis, the daughter nuclei show resting stage. In the homotypic division the spindles are either parallel or decussate. In late anaphase, 4 J shaped chromosomes of equal size are seen at each daughter pole. A tetrahedral arrangement of the grand-daughter nuclei is often observed. The method of tetrad wall-formation is by furrowing.

14. A cytological study of pollen development in *Carica papaya.*

J. J. ASANA *and* R. N. SUTARIA, Ahmedabad.

The nucleus of the closely packed hexagonal pollen mother-cells shows a thinly distributed, faintly stained reticulum, having a single nucleolus. There is a typical synizesis stage. When the knot opens, the nuclear area is filled up with a loose convoluted spireme thread of beaded nature. No parallelism of spireme threads was observed. The second contraction stage is not clear. There are 9 bivalents lying at the periphery of the nuclear membrane. The nucleolus often shows budding.

Many multipolar and tripolar spindles were observed. Beautiful polar views of the heterotypic metaphase were seen with 9 small bivalents arranged in a ring. The bipolar spindle is broad and there are 9 distinct very small univalents at both of its poles. In telophase, the chromosomes do not fuse to form a compact mass. Many small deeply stained chromatin bodies were seen in the cytoplasm.

The formation of the daughter nuclei is very rapid. There is no interkinesis stage; and the homotypic metaphase with parallel spindles is clearly seen. In late anaphase, at each of the daughter poles there are 9 distinct very small chromosomes. In homotypic telophase, the chromosomes do not fuse; but the grand-daughter nuclei are rapidly reconstructed. The tetrad walls are formed by furrowing.

15. Reproduction in *Holarrhena antidysenterica.*

G. P. MAJUMDAR, Calcutta.

The plant appears to have given up the *seed-habit,* and has adopted *root* as the means of propagation. The root may be underground or running along the surface of the soil. Buds are produced at intervals, and from below the points of their origin roots are given out which make the new plants independent when the portions of the mother root with the buds are severed from each other. (Illustrated with drawings and photographs.)

16. A comparative study of the Chilka Lake and the Calcutta Salt Lakes.

K. P. BISWAS, Calcutta.

In this paper the author has attempted to point out the influence of physical features on the Algal flora of the two lakes. Ecological factors such as variation in rainfall, salinity, tide, discharge of debris from rivers, are mainly responsible in the formation of two particular types of algal flora such as abundance of marine algæ in the Chilka Lake and profuse growth of "Oligosaprob" and "Polysaprob" Cyanophyceae and Diatoms in the Calcutta Salt Lakes.

17. Lichens of the Western Himalayas.

AHMAD ALI QURAISHI, Lahore.

The lichen flora of Garhwal—mostly in the neighbourhood of Mussoorie—has been studied.

The following species have been collected, mostly by the writer :—

1. Sychenoblastus aggregatus.
2. Leptogium saturninum.
3. Leptogium tenuissimum.
4. Leptogium subtile.
5. Lobaria pulmonaria.
6. Parmelia perlata var. ciliata.
7. Parmelia caperata.
8. Parmelia sulcata.
9. Parmelia exasperata.
10. Evernia furfuracea.
11. Usnea florida.
12. Usnea barbata.
13. Ramalina pollinaria.
14. Ramalina farinaria.
15. Ramalina geniculata.
16. Alectoria jubata.
17. Cerania vermicularis var. taurica.
18. Endocena sp.
19. Physcia ciliaris.
20. Physcia Speciosa.
21. Physcia tribacia.
22. Physcia orbicularis var. ciliata.
23. Physcia orbicularis var. virella.
24. Lecanora atra.
25. Lecanora sambuci.
26. Leciographa scapanaria.
27. Combea sp.
28. Opegrapha viridis.
29. Graphina anguina f. radiata.
30. Graphina anguina f. pulverulenta.

The structure and ecology have also been investigated.

18. Some petrified palms from the Central Museum, Nagpur, C.P.

B. SAHNI, Lucknow.

A few years ago (*Ind. Sci. Congr., Madras, 1922; Journ. Proc. Asiat. Soc. Bengal, Vol. 18, pp. 123-124*) the author described several species of indian petrified plants from various localities in India and Burma. The present paper refers to some further specimens recently received from the Central Museum, Nagpur. Some of the specimens were discovered near Saugor, C.P., others near Nagpur; they are probably all derived from the intertrappean series.

19. On a collection of petrified tree trunks discovered in the Eden Gardens, Calcutta.

B. SAHNI, Lucknow.

The author, while spending a vacation in Calcutta during the summer of 1922, discovered about a dozen petrified trunks of different sizes, lying on one of the rockeries in the Eden Gardens, not far from the Pagoda.

Most of the specimens were lying flat, but a few were standing erect and partly buried in the ground. There can be no doubt that the specimens had been purposely placed there long ago but apparently all records or recollection of them had vanished.

Considering that the Eden Gardens are one of the most frequented spots in Calcutta it is surprising that these large relics should so long have escaped notice. There can be no question of their having been originally on the spot where they were found, and their association with the Pagoda which was brought over as a trophy of the Second Burmese War, suggests that they may also have been imported from Burma at the same time.

The wood is dicotyledonous and fairly well preserved. The anatomy is described in one of the best preserved specimens.

20. Observations on a gemmiparous Metzgeria from Mysore.

L. N. Rao, Bangalore.

In this brief article a gemmiparous Metzgeria from Mysore has been described. In the mode of occurrence of the gemmae, this specimen does not resemble any of the so far recorded species. The postical position of the gemmae on the thallus has been described by Lindberg in five different species of Metzgeria; but the same has been refuted by Evans, on the basis of his observation of the same species as well as many more of his own collection. The writer's observations tally with those of Lindberg, so far as the postical position of the gemmae is concerned. In other characters like the absence of marginal gemmae, hooked hairs and dimorphic branches (gemmiparous and non-gemmiparous) this species stands apart.

21. The Golgi apparatus in higher Fungi.

S. R. Bose, Calcutta.

Few botanists have turned their attention to the Golgi bodies in plant-cells. Guiliermond of Paris in 1922 obtained Golgi apparatus in barley roots by the silver-impregnation method of Golgi. Recently in March 1926, he published a paper in C. R. Acad. des Sciences on the relation between the plant vacuolar system and the Golgi apparatus, working on *Iris germanica, Elodea canadensis,* some Chlorophyceae, Cyanophyaeae, Bacteria, and some Fungi (Levure and *Oidium lactis*). Following the methods of Cajal and da Fano he could successfully impregnate the precipitates of vacuoles in the form of a black net-work, which exactly resembled the Golgi apparatus of animal cells. Thus he is of opinion that the plant-vacuolar system and the Golgi canals of animal-cells are morphologically and physiologically equivalent. This is confirmed by the work of Parat in a number of animal cells.

Golgi bodies in higher fungi have not been reported as yet. For the last eight months I worked on a number of our common Agarics and Polypores. Following Golgi's bichromate and silver nitrate method I have got in most of them a clear net work of blackened coil within the basidia. For the sake of comparison and confirmation, four parallel sets of treatment were employed in each case. Camera lucida drawings have been made almost in each case.

22. Artificial culture of *Ganoderma lucidus* Leyss from spore to spore.

S. R. Bose, Calcutta.

Ganoderma lucidus is very common here, being a cosmopolitan species. It is a saprophyte as well as a wound-parasite. I have described it fully with plates in Proc. Ind. Assoc. for the Cultivation of Science—1920.

Coleman has recently made a very thorough and interesting study of the nature of the spore wall in Ganoderma (Bot. Gazette, March 1927). He could not obtain a single germination of spores of the species.

By employing malt-extract-agar medium, *pH* value of which was 6.8., I have finally succeeded in getting the germination of spores and further progress of the mycelium.

Mycelial transfer to block of sterilised wood of *Mangifera indica* within sterile Roux tube has produced a small hemispherical humpshaped fructification after an interval of about five months. The microscopic examination of the sporophore showed a number of typical spores of *Ganoderma lucidus.* The spore-deposit can be seen on the sides of the culture-tube in the form of a cloudy mass.

23. Grasses of the town of Dacca and its neighbourhood.

H. K. DATTA, Dacca.

In this paper a description of the climate and soil of the place, and a list of the grasses found, with a short description of their general habits and uses, have been given.

24. A note on the orientation of shoot-buds from root-cuttings.

T. S. SABNIS, Cawnpore.

Loose sand on top of light loam forms a good medium for root-cuttings.

Position of cuttings in sand-bed, time of budding, as well as mode of orientation of shoot-buds varies in different plant species.

Polarity correlates with the tendency to bud centrally.

Anatomy helpful in the study of the origin of shoot-buds from root-cuttings.

Woody tissue greatly influences the formation of shoot-buds from root cuttings.

Manipulation of temperature may help in raising plants from root-cuttings with feeble development of woody tissue.

25. Importance of iron for the growth of Fungi (*Fusarium vasinfectum* Atkinson).

B. B. MUNDKUR, Dharwar.

Fusarium vasinfectum Atkinson was grown in media with and without iron in order to determine if iron exercised any influence on the growth of the fungus. It was observed that in solutions with iron there was more growth than in solutions without iron. It is concluded that for some fungi at any rate iron acts as a stimulant even though they do not have chlorophyll and therefore do not need it.

26. Results of a cross between a cultivated and a wild rice.

S. K. MITRA *and* P. M. GANGULI, Jorhat, Assam.

The inheritance of wild character in rice has not yet been studied in detail. In 1923 a few grains of a cultivated variety were crossed with a wild plant. The F_1 generation proved to be successful with the wild character as dominant. The F_2 and F_3 generations were grown in successive years and their characters noted in regard to vegetative growth as well as colour of the parent plants.

The results may be stated as follows :—

The colour of leaf-sheath, pulvinus, ligule, node, internode, tip and stigma segregated in F_2 in the ratio of 3 : 1 approximately. In F_3 all the green plants bred true while the coloured plants segregated in the ratio of 1 : 2 : 1 more or less.

The colour of auricle, outer glume and inner glume segregated in the ratio of 15 : 1 approximately. In all cases the recessive characters splitted up in F_3.

The colour of mature inner glume and the kernel segregated in F_2 in the ratio of 1·3 : 1 and 9 : 6 : 1 respectively.

The awny, spreading, and shattering habits of the wild rice were dominant both in F_2 and F_3 and some intermediates were produced in each case giving a ratio of 12 : 3 : 1, 1·3 : 1 and 3 : 1 respectively.

27. Observations on inheritance in rice.

S. K. MITRA, S. N. GUPTA *and* P. M. GANGULY, Jorhat, Assam.

Some of the characters in rice such as awny inner glume, glutinous kernel, etc., have a bearing on the relative appearance and value of the grains. It is of great importance from the breeder's point of view. A number of crosses were tried at the Karimganj Farm, Assam, from the economic point of view and the following characters were studied:—

(1) Awn character in rice (awny vs. awnless).
(2) Straw " " " (Strong vs. weak).
(3) Size (spikelet) " (large vs. small).
(4) Glutinous " " (glutinous vs. translucent).
(5) Flowering " " (early vs. late).

The results of segregation in F_2 in each case may briefly be stated as follows:—

Out of 9 families awny character was dominant in 4 and awnless in 5 cases, and they segregated in different ratios of 3 : 1, 1·3 : 1, 1 : 2 : 1 and 9 : 6 : 1.

Straw character in rice was studied in two crosses segregating in ratios of 3 : 1 and 1·3 : 1. Strong straw being dominant in the former and recessive in the latter.

A cross between a large and a small spikelet in one family segregated in the ratio of 1 : 2 : 1 and likewise a cross between an early and a late variety gave a similar ratio.

Glutinous character in rice was studied in three families two of which segregated in the ratio of 3 : 1 having abdominal opaque type dominant, while a cross between a wild rice and a cultivated one produced intermediates and a translucent type which was not in the parental varieties in the ratio of 1 : 2 : 1.

28. Observations on the anatomy and physiology of the aerial roots of the banyan tree.

SHAMSHER SINGH, Indore.

The anatomy of the aerial root (both primary structure and secondary growth) is described, with special reference to the velamen. The structure is of the usual root type. The velamen, in the earlier stages of the root is 15 to 25 layers of cells in thickness. It is developed wholly from the dermatogen.

Some physiological experiments on the conduction of water by the roots are described. In pieces of roots whose tips have been cut away the water is absorbed and conducted equally rapidly from both ends, i.e., in both directions. In cut pieces with entire root tips the water is not absorbed and conducted rapidly by the other end. There is thus no obstacle to the flow of water in either direction if it once gets into the vessels.

The roots bear no root hairs so long as they are in the air, but when they have entered the soil root hairs are developed.

29. A note on the elaioplasts in the tubers of *Cyperus rotundus* Linn.

S. B. RANADE, Poona.

In continuation of the microchemical study of the tubers of *Cyperus rotundus* described in the Memoir of Imperial Department of Agriculture, Pusa (Vol. XIII, No. 4), the elaioplasts scattered among the starch containing storage cells of the cortex and pith were studied.

The elaioplasts were single cells containing granular oil sacs.

Microchemical reactions, similar to those followed by Beer (Annals of Botany, Vol. XXIII, Jan. 1909) were tried and are described.

The elaioplasts found in *Cyperus rotundus* are compared with those found in Gaillardia, *Agave americana*, etc., with figures.

30. Root-rot of wheat caused by *Pythium graminicolum* n. sp.

L. S. SUBRAMANIAM, Pusa.

A species of Pythium parasitic in the roots and leaf-sheaths of wheat was isolated from Dharwar.

It differs from *Pythium aphanidermatum* (Eds.) Fitz. in the branching of antheridium and the oospores filling the oogonium.

The identification of the Pythium on sugarcane by Carpenter as *Pythium aphanidermatum* is not accepted.

The name *Pythium graminicolum* is proposed for the Pythium found on wheat and sugarcane.

31. A comparative study of Indian Avicennias.

K. P. BISWAS, Calcutta.

In this paper a side by side comparison has been made of the different species of Avicennia, viz.—*Avicennia officinalis*, *Avicennia alba* and *Avicennia tomentosa.* Though the last two species have been reduced to *Avicennia officinalis* Linn. in the Index Keweusis, a detailed study of germination, morphology, anatomy and ecology show that they are three distinctly separate species.

32. Notes on the vegetation of the Khasi Hills.

S. P. AGHARKAR, Calcutta.

The paper includes results of an investigation into the floral elements composing the flora of the Khasi Hills and their origin.

33. On a fossil pentalocular fruit from Pondicherry, S. India.

B. SAHNI, Lucknow.

Describes a pentalocular fruit 2½ cm. in diameter embedded in a fresh water sandstone from Pondicherry. The specimen was received on loan from the Department of Geology, British Museum, London. The horizon, although not known with certainty, is probably the Cuddalore Sandstone (Tertiary), from which series no angiospermous plant remains have yet been recorded. In fact, the author is not aware of any fossil fruit of a similar type from any part of India. The affinities cannot be determined without an extensive comparison with modern dicotyledonous 5-locular fruits, and the author will exhibit the specimen mainly with the object of inviting opinion from systematic botanists.

34. Note on some epizooic algæ from Bengal.

M. O. T. IYENGAR *and* M. O. P. IYENGAR, Madras.

Three algæ (*Characium* sp., *Bulbochaete* sp., and *Oedogonium* sp.) were found growing profusely on living mosquito larvae. A detailed account of the algæ is given in the paper.

35 On the structure of the cell-walls of some South Indian Caulerpas.

G. SESHADRI IYENGAR, Madras.

A study of the structure and chemical composition of fifteen species of Caulerpa from South India was made to find out if the different species showed any difference in the structure and chemical composition of their cell-walls and trabeculae.

The cell-wall consists of an outermost layer which is insoluble in sulphuric acid and a number of inner lamellae which are soluble in the acid. The lamellae consist of three substances, (i) a substance which is not cellulose but soluble in concentrated zinc chloride, (ii) pectose, and (iii) a substance which is neither of the two above, but soluble in sulphuric acid.

These three substances were not found in the same proportion in the different species. The species differed from one another in having varying proportions of these substances.

There is also a certain amount of difference in the composition of the cell-wall of the stolon, rhizoid and ramules of the same species. The trabeculae also differed in their chemical nature from the cell-wall to a certain extent.

In a few species, certain peculiar inwardly projecting conical processes occur in large numbers on the cell-wall. These conical processes are seen principally on the walls of the ramules and only very rarely on the stolon or on the rhizoid.

36. On two green algæ (*Protosiphon* and *Cylindrocystis*) growing on white-washed walls in Madras.

M. O. P. IYENGAR, Madras.

During the rains of the North-east monsoon a species of *Protosiphon* and a species of *Cylindrocystis* grow in plenty on newly white-washed walls forming a dark green coating on them. All the various stages of the *Protosiphon* were observed. Towards the end of the rainy season, cysts are formed in large numbers inside the alga which soon turn red giving the wall a reddish appearance.

The *Cylindrocystis* is a very small species coming near *C. Brebissoni* Menegh. The desmid was conjugating freely and plenty of zygospores were observed, the wall of the ripe zygospore taking a deep blue tint. Desmids usually do not flourish in waters containing carbonate of lime in solution. This alga, therefore, is very interesting in that it grows plentifully on calcium carbonate itself (viz., the white-washed layer of the wall).

37. A study of the Mussoorie ferns.

T. C. N. SINGH, Lucknow.

The following eighteen species (including one variety) have been included: *Leucostegia hymenophylla* Parish MS., *Onychium auratum* Kaulf., *Pteris quadriaurita* Retz., *Pteris pellucida* Presl., *Woodwardia radicans* Smith., *Asplenium alternans* Wall., *Asplenium viride* Hudson., *Asplenium pumilum* Sw., *Asplenium pekinense* Hance., *Polystichum aculeatum* Sw., *Polystichum aculeatum* var. *rufo-barbatum* Wall., *Polystichum auriculatum* var. *caespitosum* Wall., *Lastrea rigida* Desv., *Lastrea fuscipes* Wall., *Nephrodium costatum* Wall.' *Nephrodium microsorum* Clarke., *Polypodium zeylanicum* Mett., *Polypodium adspersum* Bl.

The study is sub-divided under the following headings: (1) the anatomy of (*a*) the rhizome, (*b*) the root, and (*c*) the leaf; (2) the venation of the leaf; (3) the epidermis; (4) the form and structure of the scales

and hairs; (5) the form and structure of the indusium (6) the form and surface characters of the spores; (7) discussion of results and theoretical considerations.

38. A note on the presence of a sporangium on the indusium of Cheilanthes.

T. C. N. SINGH, Lucknow.

Besides the normally situated sporangia on the placenta covered by the indusium, a case has come to my notice in which a normal looking sporangium is borne on the margin of the indusium of a species of Cheilanthes from Mussoorie.

39. A note on vegetative reproduction in two mosses from Mussoorie.

T. C. N. SINGH, Lucknow.

The two mosses studied are (1) *Bryum hemisphaericarpum* C. Mull. in which case a large number of short club-shaped gemmae are produced in an acropetal succession on a cushion of tissue situated in the axils of leaves. Most of the leaves on the plant bear gemmiferous cushions of the types described above such that when examined superficially, the plant looks like a mature strobilus of Selaginella. The gemmae have hook-like outgrowths at their apices. (2) *Philonotis turneriana* Mitt.: in this case, small leafy bulbils are produced in the axils of leaves at the stem apices.

40. A note on the teratology of certain angiosperms.

T. C. N. SINGH *and* B. N. SINHA, Lucknow.

The authors record abnormalities in the following five types: (1) *Datura Metel* L.: In this case, the flowers sometimes show, besides the normal five stamens, an extra sixth stamen which is exactly like a normal one, both in its internal and external morphology. (2) *Cosmos sp.*: Fasciation of capitulum. (3) *Phlox sp.*: Nearly half a dozen abnormal flowers have been examined. They show variation in floral parts, specially in calyx (K_{4-6}), corolla (C_{3-6}) and androecium (A_{5-6}). (4) *Trichosanthes dioica*: Fasciation of fruits (a homologue of two) is described. It is interesting to note that each of them is tri-carpellary. (5) *Helianthus annuus* L.: An abnormal capitulum shows seven leaf-like structures looking like involucral bracts (in the centre), each borne in the axil of a chaffy bract. It is concluded that they are homologous to the habitually (nearly) abortive sepals which have—through some physiological circumstance—become leafy and the corresponding flowers bearing them have aborted.

41. A note on the external features of *Cycas circinnalis*.

M. A. SAMPATHKUMARAN, Bangalore.

A detailed account of the external features of the vegetative and reproductive organs of the plant is given. Special attention is drawn to features which have not been previously recorded.

42. Further researches on the relation between the water content and carbon dioxide absorption of leaves.

R. H. DASTUR *and* R. E. COOPER, Bombay.

43. The mechanism of curvature of the tendrils of Cucurbitaceae.

R. H. DASTUR *and* G. H. KAPADIA, Bombay.

44. On some Phalloids collected in Mysore Province.

M. J. NARASIMHAN, Mysore.

No Phalloids have been so far recorded from the Mysore Province. The author has within the last seven years collected the following Phalloids from the Malnad (Western Ghats) region of the Mysore Province :—

1. *Colus Gardneri.*
2. *Clathrus delicatus.*
3. *Simblum periphragmoides.*
4. *Aseroe arachnoides.*
5. *Dictyophora phalloidea,*

Of these, the first three occur in fairly large numbers during the heavy monsoon rains of July and August, and the last two come up immediately after the rains have ceased.

Colus Gardneri and *Clathrus delicatus* have been known so far only from Ceylon. Several interesting forms of the former Phalloid have been collected by the author—a study of which has made him come to the conclusion that the separation of the two genera, *Colus* and *Pseudocolus,* can no longer be maintained and that the two genera should be merged into one single genus.

The anatomical structure of the gleba and the arm of *Colus Gardneri* has been studied in detail.

45. A curious mode of reproduction in an aquatic species of Anabaena.

S. L. GHOSE, Rangoon.

46. Variation in *Sphæropsis malorum.*

KIRPA RAM MOHENDRA.

Sphæropsis malorum along with four other fungi described in a separate paper was cultivated on a number of media using three different kinds of inocula.

On one of the media used, sporal and mycelial inocula gave different kinds of cultures. Analysis of the factors responsible for this difference established that spores in a single Pycnidium are of strikingly heterogenous nature. On plating out, these spores give different types of colonies (*e.g.*, black and white).

A general account of the variability of the fungus together with a discussion of the difficulties of interpretation involved is given at some length.

Two celled spores noticed in *Sphæropsis malorum* indicate the desirability of re-arranging the genera, Sphæropsis and Diplodia.

47. A study of the changes undergone by certain Fungi in artificial culture with special reference to the occurrence of saltations.

KIRPA RAM MOHENDRA

A detailed study of the cultural behaviour of four species of fungi, *Neocosmospora vasinfecta, Phoma A, Phoma B,* and *Alternaria tenuis*

has been carried out on a number of media. The experimental work was devised in the first instance to test the theory that different kinds of inocula possess different potentialities as regards the kind of colonies to which they give rise.

For this purpose parallel lines of transfers were set up (*a*) Using young mycelium only, (*b*) Using old mycelium only, and (*c*) Using spores only as inocula. These series were carried down through a number of generations and from time to time comparisons of the various lines were made under standard conditions with a view to determining whether any changes in cultural characters had taken place.

The general result of these comparisons was to show that each original strain remained constant under the different methods of cultivation adopted.

Saltation took place on a number of occasions, so that several new forms were isolated. The liability of saltant forms to appear in the cultures necessitates a certain amount of care in order to avoid replacement of the parent strain by the saltant.

The properties of the parent and the saltant strains were compared in the case of each fungus. From the data so derived it is possible to indicate how far certain cultural features of the fungi concerned are of value for systematic purposes.

Section of Geology.

President:—Prof. H. C. Das-Gupta, M.A., F.G.S.

Presidential Address.

A Record of Fifty Years' Progress in Indian Pre-Mesozoic Palaeontology.

INTRODUCTION.

By asking me to preside over the Geological Section of the Indian Science Congress the authorities of the Congress have done me a great honour and I appreciate it very much. In the year 1877 the late Prof. Waagen (1) published a paper dealing with the distribution of the fossil organisms in India. Considerable progress has been made in our knowledge of Indian fossils since then and I wish to avail myself of this opportunity to attempt a review of the advance made in the sphere of the Indian pre-Mesozoic fossils during the last fifty years. It is true that on different occasions authors like Feistmantel (1), Lyddeker (2,6) and Sahni (1) made very important contributions to our knowledge of the pre-Mesozoic Indian fossils by presenting summarised reviews, but each of these authors dealt with a part of the fossil organisms and a brief review of the pre-Mesozoic invertebrate fossils is to be found nowhere and in the present address an endeavour will be made to summarise the progress made during the last fifty years in all branches of pre-Mesozoic Indian palaeontology. A good account of the fossils described up to the year 1893 is to be found in Oldham's book (2) but the book has been out of print for many years while Wadia (1) and Reed (9) in their books did not pay any special attention to the fossils.

Periods in the Development of Geology and Palaeontology in India.

In his work dealing with the history of Geology and Palaeontology, Zittel recognised four different periods of their development in Europe. The first period was primarily one of Cosmogeny and Geogeny. It began from hoary antiquity the traces of which have been preserved for us chiefly in the shape of traditions and it ended with the downfall of the Roman Empire. The second period began from the 15th century, the time of the European Renaissance, and ended with the beginning of the Heroic age (the third period) which lasted from 1790 to 1820. In the fourth or the modern period the geo-

logical and palaeontological works are chiefly in the hands of the Universities, the State Geological Surveys and the Geological Societies. If an attempt is made to trace the development of geological including geogenetic and cosmogenetic ideas in India, three different stages can be easily marked out, the second of which I am tempted to designate as the Heroic age. It dates from 1784, the year of the foundation of the Asiatic Society of Bengal, and ends with 1856 when an official Geological Survey department was established. The first period dates from the days of myth and tradition and ends with the 9th or the 10th century A.D. and, though during this period, the Hindu ideas of Geology were of an extremely crude nature, a remarkable stride was made in the knowledge of the macroscopic physical characters of the gems as already shown in a short paper of Das-Gupta (5) while reference to the translation of Kautilya's Arthashastra by Dr. Shama Sastri (1), which belongs to the period 321–296 B.C., shows that during this period the State had a monopoly in mining as well as in mineral industry, and maintained a mining department placed under the control of a learned Superintendent. For an understanding of the ancient Hindu ideas regarding cosmogeny and geogeny reference may be made to the Vedas and other sacred books, while it has been pointed out by Sir P C. Ray (1) that the ancient Indian philosophers were convinced of the internal heat of the earth and of the igneous origin of rocks and minerals.

The foundation of the Asiatic Society of Bengal—an event of supreme importance so far as the cultural development of India is concerned—may be said to usher in an era of Renaissance in India after a long period of dark ages due chiefly to political strife and unrest. The Society was established on a very ambitious plan as is quite apparent from its motto which is well known and has often been quoted. This is not the place to judge how far the Society, by its work during the last fourteen decades, has been able to realise its aims, but it may be said, without any fear of contradiction, that so far as the pioneer works in the different branches of Indian Natural History are concerned, a considerable achievement was made under the auspices of this Society and among the naturalists who laid down the foundation of Indian palaeontology during this Heroic age we may mention the names of Sir W. E. Baker, H. J. Carter, Sir P. T. Cautley, H. Falconer, H. T. Colebrook, J. Colvin, A. Fleming, J. G. Gerard, C. T. Kaye, J. McClelend, J. Prinsep, G. G. Spilsbury and N. Vicary. It may also be pointed out that the first work on Indian palaeontology dealt with the fossil wood of Trivicary and was published in the 12th volume of the Asiatic Researches by J. Waren in 1810 and to the Asiatic Society of Bengal also belongs the credit of the posthumous publication of the work of Dr. H. W.

Voysey who was appointed Surgeon and Geologist to the surveying party of Col. Lambton and has been described as the Father of Indian Geology. Reference to this band of pioneer workers is certainly outside the scope of the present address and their inclusion in it can only be justified on the ground that it gives us a proper perspective to appreciate the contributions of those who succeeded them.

OLDEST FOSSILIFEROUS BEDS OF INDIA.

Students of Indian Geology need not be reminded of the controversy that has been raised round the question as to what beds are to be looked upon as the oldest in India. It is well known that the Geological Department of Mysore first raised its voice against the ordinarily accepted relationship between the Dharwars on the one hand and the crystalline gneisses and the schistose complex on the other. In his presidential address delivered at the Bombay session of the Indian Science Congress in 1919 Dr. Fermor (1) put the Dharwar series as the oldest series of the rock-formations recognised in India, and thus expressed his agreement with the opinion of the Mysore Geological Department, but held that the Dharwars were of a heterogeneous nature being partly sedimentary and partly igneous, while the so-called fundamental gneiss was younger and considerably made up of re-melted pre-Dharwar gneisses not hitherto recognised anywhere in their original state. Mr. Jones and his collaborators in Chota Nagpur have also found field evidence justifying the relegation of the Dharwars to the very bottom of the Indian Archæans. At the time of the publication of Prof. Waagen's paper the Silurian fossils were the oldest remnants of life known in India, but in course of the last fifty years the existence of the Indian Cambrian life has been definitely established and contributions towards the demonstration of the existence of the pre-Cambrian and the Archæan life in India are not entirely wanting. Mention should be made, in this connection, of the presence of graphite in the crystalline limestone associated with the Archæan Mogok gneiss of Burma and of the opinion of Mr. La Touche (3) that the graphite of this area might be of organic origin. Ghosh (1) has described organo-genetic markings on specimens of Dharwar phyllite. Immense deposits of iron and manganese ores are associated with the rocks of the Dharwar series and Ghosh has suggested that the presence of carbonaceous phyllites as exhibited in the deep workings of the Dharwar gold mines and the contemporaneous manganese—and iron ore deposits may be indicative of organic life in the Dharwar time. The Dharwar iron and manganese—iron ore deposits are looked upon as being of syngenetic sedimentary nature, but no direct evidence of any organic intervention has been proved. It may

be noted, however, that the iron ores of Bihar and Orissa have been included under a new name of the Iron-ore series by Mr. Jones. It overlies the rocks typically known as the Dharwars and is Archæan and pre-Cuddapah in age. As pointed out by Dr. Fermor (2) and Sir Edwin Pascoe (3), two divisions of the Dharwars are recognised in Bihar and Orissa, the Iron-ore series and the associated volcanic flows constituting the upper division, while the lower division is represented by the rocks hitherto recognised as the Dharwars. In course of the discussion of the sedimentary origin of the Dharwarian iron-ores in India, it is necessary to point out that, according to Parsons (1), the ores of the Iron-ore series owe their origin to replacement by hot magmatic solutions rich in iron and not to sedimentation.

Purana Group.

Sir Thomas Holland (5) proposed the term Purana group to include vast thicknesses of unfossiliferous sedimentary beds found both in the Peninsular and in the Extra-Peninsular India and lying between the Archæan and the undoubted fossiliferous rocks. The Purana group probably includes beds of more ages than one, and, on account of the complete absence of fossils in them, the standard for their correlation must be sought for elsewhere and a scheme of correlation based on petrologic methods, so far as the Himalayan Purana beds are concerned, is to be found in a recently published paper of Das-Gupta (6) which also contains the full story of the discovery of *Chonetes sp.* in the Krol beds and of the doubt thrown on the correlation of the beds in which the fossil was found. This is, however, not the only reported occurrence of fossils in the Purana group of the Himalayas, but substances of doubtful organic origin have also been recorded from it. Thus Sherborn (1) described a concentric limestone probably of organic origin and resembling *Cryptozoon proliferum* Hall. The late Prof. Nicholson considered that it was more of an organic origin and very similar to *Stromatictis*, while R. D. Oldham (1) noted the occurrence of a similar structure of doubtful organic origin in the Deoban limestone. Sir Thomas Holland also described a concentric Stromatoporoid structure in a dolomite of Gohna (Garhwal) and it may be recorded that, in course of his description of the geology of the Naini-Tal area, he (2) referred to some oolites of a possible organic origin. A few discoveries of fossils or pseudo-fossils in the Purana rocks of the Peninsula have also been recorded. According to Beer (1), a spiral impression of doubtful organic origin has been found in the lower Vindhyan limestone of Rhotas, the impression, if organic at all, being more of a helminthic than of any other type. A few pseudo-fucoids were described as occurring in the Upper Vindhyan Sandstones by Vredenburg (1), some of which are iden-

tical with the markings found in the Silurian of Portugal while a slab of Vindhyan sandstone described from the neighbourhood of Jodhpur contains chordophyceous markings of a very definite structure consisting of a number of swellings connected together by a number of tentacle-like filaments. Prior to this, LaTouche doubtfully referred a few markings found in the Vindhyan sandstone to a vegetable or piscine origin. About 20 years ago, Mr. Jones (1) exhibited a few fossil specimens collected from shales belonging to the Upper Vindhyan. According to Sir Edwin Pascoe (4), an examination of these materials has shown that they are brachiopods and agree most closely with the Cambrian *Acrothele.* Concentrically laminated patches of limestone with interlaminated patches of siliceous matter from the Cheyair beds were described by King (1) by whom these structures were connected with the overlying lava-flow, but it was suggested by Vredenburg (3) that these laminated patches might be referable to the genus *Cryptozoon*. Vredenburg further recorded the presence of this genus in the Cuddapah beds off Raipur and in the Gwalior series of Central India. The Raipur specimen, according to Vredenburg, resembles the Australian species *C. tessellatum* Howchin. The full paper of Vredenburg has not been published, but it appears that the concretions described by Hacket (1) in the Morar group were also identified by him as belonging to the same genus. Sometime ago Mr. Sailendra Nath Sen, a former pupil of mine and at present engaged as a geologist to Tata's Iron and Steel Works, showed me certain specimens obtained from the neighbourhood of Raipur which recalled at once the form of *C. australicum* described by Howchin (1). The specimens were obtained from beds which are apparently of Cuddapah age. The algal nature of *Cryptozoon* appears to have been established by Wieland (1). It should be mentioned, however, that pseudo-cryptozoon structure is also sometimes met with and Howchin (3) has described how it may be distinguished from a genuine *Cryptozoon.*

Scarcity or want of fossils in the Purana Group.

In the foregoing review I have confined myself to the contribution to our knowledge of the Purana Palaeontology since 1877 but, in order to make the story complete, a reference may also be made to our knowledge on this point previous to the year 1877. Thus we find that about 90 years ago, impressions of organic origin from the Transition (Purana) slate and limestone in the neighbourhood of Almorah were described by McClelland (1), while a reference to the description of the Vindhyan beds by Mallet (1) also shows that a number of the earliest explorers described what they thought to be organic remains occurring in them. According to Sir Thomas Holland (5) the Purana group is correlated with the Algonkian beds of

Canada and the rocks of both these groups of beds have the same story to tell regarding the fossil remains. The practical absence of pre-Cambrian life is a mystery in the light of the great abundance of the Cambrian fauna and though the discovery of *Atikokania*, *Beltina* and a few other forms of life has shown that the beds older than the Cambrian contain traces of past life, the record is a very meagre one. The intense metamorphism to which the Archean rocks were exposed may account for an almost complete obliteration of organic traces in them, but the nature of the Purana rocks does not admit of any such explanation. Sir Thomas Holland (2) is inclined to hold that metasomatic replacement of lime by magnesia in the case of the Purana limestone may be one of the causes of the absence of undoubted organic remains in them. A case of an almost complete obliteration of all organic remains by means of dolomitisation has been reported from the Plateau limestone of Burma by LaTouche (3), while a similar case of obliteration of all traces of organism has been recognised by Howchin (2) who has given a short account of the opinions held regarding the origin of unfossiliferous limestones and in it reference has been made to the chemical precipitation theory of Daly, the calcareous algae theory, and that of dolomitisation. To these may be added the theory of Brooks which, as described by Daly (1) involves 'the long postponement of the sea-bottom' (the photobathic zone of the sea) by the primitive animals and the suggestion of Macgregor (4) that the pre-Cambrian limestone was a precipitate obtained from a saturated solution of bicarbonate and hence it is unfossiliferous. The dolomitic nature of many of the Purana rocks and the presence of Cryptozoon-like bodies in some of them are quite in agreement with some of the theories mentioned above. It may be remarked in this connection that, according to Wieland (1), the pre-Cambrian, Cambrian and Ordovician periods witnessed the greatest development of Algae.

Cambrian Fossils.

Cambrian fossils have been found in the Salt Range as well as in Spiti and Middlemiss (3) has referred to the possible occurrence of the Cambrian beds in Kashmir with obscure fossil remains. The correlation of the Tawng-Peng system of Burma with the Cambrian has been established by LaTouche (3) on stratigraphic and not on palaeontological grounds since no fossils have been found in the former and, as suggested by Sir Thomas Holland (6), this system may be included under the Purana group. Though the existence of Carboniferous fossils in the Salt Range was announced by Dr. Fleming (1) 80 years ago, to Wynne (1) belongs the credit of the first discovery of a lower palaeozoic fauna supposed by the dis-

coverer to be Silurian in age. The next step was the discovery by Warth of fragments of trilobites in the beds recognised as Silurian by Wynne and their identification and relegation to the Cambrian System by Waagen as reported by King (2). In the closing part of the description of the Salt Range fossils Waagen (5) discussed the age of the fossiliferous beds lying below the Productus limestone beds and fixed the age of these beds as Cambrian chiefly on the evidence of the trilobites. The fossils described by him (with the exception of a doubtful Fenestella) belong to the Brachiopods, Pteropods and Trilobites and are all new to science. The next important contribution to the Salt Range Cambrian was by Noetling (4) who proposed a four-fold division of the Salt Range Cambrian, namely the Khewra, the Khussak, the Jutana, and the Bhaganwalla group and, in some cases, the groups were divided into a number of zones. Subsequently Redlich (1) described the palaeontological materials collected by Middlemiss, Datta and Noetling and established the genus *Hoeferia* (since changed into *Redlichia*) for the fossils described as *Olenellus sp.* by Noetling. Only one species of the genus was described (*R. Noetlingi*) and, from a consideration of the fossils, Redlich came to the conclusion that the Cambrian fauna of the Salt Range could not be referred to a horizon later than that of *Paradoxides.* Later on this opinion was corroborated by Walcott (1) who ascribed a middle-Cambrian age to these Salt Range beds. An analysis of the faunae described chiefly by Waagen and Redlich shows that the Brachiopods make up their bulk and the remaining portion is mainly composed of *Hyolithes*, *Redlichia*, and *Ptychoparia.* In course of his study of the Cambrian Brachiopods, Walcott found it necessary to introduce important changes regarding the Cambrian Brachiopods of the Salt Range and for an information regarding the distribution of the Salt Range Cambrian fossils in the different zones as established by Noetling reference should be made to a table published by Walcott (1).[1]

The first notice of the discovery of the fossiliferous Cambrian rocks in Spiti by the late Sir Henry Hayden was published by Griesbach (3). In his report for the next year Griesbach (4) referred to the Upper Cambrain age of these rocks. A detailed description of the beds was published by Sir Henry Hayden (2) who recognised three divisions of the Cambrian of Spiti covering a thickness of 4 to 5 thousand feet of which only

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[1] For a proper elucidation of the list it is necessary to point out that, according to Walcott, (i) *Neobolus Warthi*=*N. Wynnei*=*Lakhmina linguloides*=*Lsquama,* (ii) *Lingulella khurensis*=*Lingula* (?) *khurensis*= *Lingula* (?) *Warthi,* (iii) *Mobergia granulata*=*Botsfordia granulata,* and (iv) *Wynneia Warthi*=*Orthis Warthi.* Cambrian Brachipoda. *Monograph U.S. Geol. Surv.*, Vol. 51, 1912.

500 feet towards the top are fossiliferous. The term Cambrian replaced Bhabeh (Stoliczka) and Haimanta (Griesbach), the names proposed by authors who had failed to find out any recognisable organic remains in them. It may be mentioned, however, that in the greenish schists of the Bhabeh Series Griesbach (1) found traces of fossils (Bellerophon ?) in the neighbourhood of Niti, while further traces of fossils from the same series were reported on by Griesbach later on (2). The fossils collected by Sir Henry Hayden have been described by Dr. Reed (3) and consist chiefly of Trilobites, the Brachiopods being next in importance. The Trilobites are represented by a number of species all of which are new excepting four and one of these (*Redlichia Noetlingi*) is identical with a species already described and the other three, though not identical, have got affinities with pre-described species. The brachiopod genera are *Nisusia*, *Lingulella*, *Acrotreta*, *Obolella* and *Acrothele* as also *Lingulepis* and *Obolus* (*Westonia*) of doubtful determination. A few of the species show affinities with the Cambrian species of North America while others are new. Besides the Trilobites and the Brachiopods the fauna includes *Hyolithes*, *Eocystites* and *Cosinocyathus*. The fossils have been chiefly obtained from the Parahio river section where six fossiliferous horizons have been distinguished and the fossils obtained from this section are confined to the different horizons and no fossil has been found to pass from one horizon to another. There are two other localities in Spiti from which Cambrian fossils have been obtained, but their relationship with the Parahio horizons is not clear and this is very unfortunate as *Redlichia Noetlingi* was found in one of these two localities. Dr. Reed has designated the Spiti Cambrian as the Parahio series and distinguished three stages (lower, middle and upper) therein. The lower does not contain any Trilobite and consists of only one horizon; the middle stage is characterised by the presence of *Ptychoparia* and consists of four horizons, while the upper consisting of only one horizon contains probably representative of *Olenus*. According to Dr. Reed the upper stage corresponds to the upper Cambrian, the middle stage to the middle Cambrian and the position of the lower stage is doubtful but possibly it also belongs to the middle Cambrian. Dr. Reed has further expressed an opinion that the *Redlichia Noetlingi*-bearing bed of Spiti is possibly representative of the lower Cambrian and this is tantamount to fixing the age of the Salt Range Cambrian as lower Cambrian. But there are certain considerations which have led me to hold a different view regarding the age of the Salt Range Cambrian and they are discussed below.

According to Frech (1) the Salt Range Cambrian was at first considered as belonging to the lower Cambrian and this was chiefly due to the identification of *Redlichia Noetlingi* (Redlich)

as *Olenellus sp.* by Noetling. As already noted, the fossils collected by Noetling, Middlemiss and Datta were studied by Redlich (1) who was of opinion that the Salt Range Cambrian could not belong to a horizon later than the *Paradoxides* bed while Walcott (1) held that the Cambrian of the Salt Range should be relegated to the middle division. Noetling (4) divided his Khussak group into five zones and, taking them in an ascending order, the zones I to III are characterised by the abundance of *Hyolithes*, the zone IV consists only of Brachiopods and the zone V includes a few Brachiopods and *Redlichia Noetlingi*. *Wynnia Warthi* (zone III) is the oldest Brachiopod of the Salt Range Cambrian. It has been compared by Walcott (1) with *Nisusia festinata* of the lower Cambrian and with *Billingsella Romingeri* of the middle Cambrian. The Brachiopods which occur in zone IV are *Discinolepis granulata, Schizopholis rugosa, Neobolus Warthi* and *Lingulella khurensis*. According to Walcott the first three genera 'indicate a stage of development more advanced than that of the Brachiopods of the Cambrian fauna in other parts of the World,' while regarding *Lingulella khurensis* the same author (3) has remarked that 'the first impression made by the shell when comparing it with the other species of *Lingulella* is that it is an Upper Cambrian type.' The Brachiopods of zone V are *Lingulella Fuchsi, Lingulella Wanniecki* and *Botsfordia granulata*. *Lingulella Fuchsi*, according to Walcott (1), 'suggests the upper Cambrian *Lingulepis*-like shells.' *Lingulella Wanniecki* is allied to *L. desiderata* ranging from the middle Cambrian to Ordovician and to *Lingulella Oweni* of upper Cambrian; while, according to the same author (3), *Botsfordia granulata* is very closely related to *B. pulchra* of the middle Cambrian. Only one of these Brachiopods, *Lingulella Fuchsi*, has continued to the overlying Jutana group.

The next important fossil that may be investigated for the purpose of finding out the age of the beds is *Redlichia Noetlingi*. The genus *Redlichia* is supposed by Walcott (4) to be a descendant of the lower Cambrian *Callovia*, though he (1) at first held that it was the direct descendant of *Olenellus* and lived in the late lower Cambrian or middle Cambrian time and came to the conclusion that the Salt Range Cambrian possibly belonged to the middle stage. Dr. Reed's monograph (3) on the Spiti fossils was published in 1910 and at that time besides Dr. Redlich's description of *Hoeferia* (= *Redlichia*), a few species of the genus had been described from the lower Cambrian beds of China. These Chinese species were compared but not identified with *R. Noetlingi* and very likely this led Dr. Reed to place the *R. Noetlingi*-bearing beds as lower Cambrian. But the present detailed knowledge about the distribution of *Redlichia* shows that outside India the genus has been recorded from the lower Cambrian of Yunan and Tonkin by Mansuy (1, 2) and of China by Walcott (2), the

middle Cambrian of China and Australia by Walcott (4) and Foord (1) respectively and the upper Cambrian of Australia by Howchin (2) and Etheridge (1). Thus the genus *Redlichia* may be considered to be ranging throughout the whole Cambrian system. Among the different species of *Redlichia* that have been described, *Redlichia Noetlingi*-seems to be most closely related to *R. Forresti* mentioned by Etheridge (1). From what has been stated above it follows that so far as the evidence of the fossils in zone IV is concerned the balance is more in favour of looking upon them as being of the upper Cambrian age and the evidence of *Redlichia Noetlingi* is not against it. In consideration of this and also on account of the fact that the nature of the rocks shows that they belong to one series of sedimentation without any break I am inclined to propose the following revision of the correlation of the Punjab Salt Range Cambrian section as shown below :—

Bhaganwalla Group.		
Jutana ,,		Upper Cambrian.
	Zone V	
	,, IV	
Khussak ,,	,, III	
	,, II	Middle Cambrian.
	,, I	
Khewra ,,	No fossils	..Lower Cambrian (?)

The presence of *Redlichia* in and the absence of *Olenellus* from the Cambrian beds of Australia [1] and a general consideration of the other genera found in the Indian and the Australian Cambrian beds would lead one to conclude that the South Australian sea of Frech (2) was connected with the Chinese sea on the one hand and the Punjab sea on the other, so that the genus *Redlichia* could find a free passage of communication. It may be added that the great difference between the Spiti and the Salt Range faunas shows that they must have been developed in two distinct regions with a means of communication for the passage of *Redlichia Noetlingi*. Mansuy (3) has already drawn attention to the extremely localised nature of the Cambrian zoological provinces and the Indian occurrences support this. The chief Cambrian fossils from Spiti are *Agnostus spitiensis*, *Microdiscus Griesbachi*, *Microdiscus haimantensis*, *Redlichia Noetlingi*, *Oryctocephalus Salteri*, *Ptychoparia spitiensis*, *P. Stracheyi*, *P. consocialis*, *P. admissa*, *P. pervulgata*

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[1] The following remarks of Walcott may be quoted in this connection: 'With our present information, the *Mesonacidæ* is confined to Western Europe and North America. The immediate descendants of the family are probably *Paradoxides* about the Atlantic Basin and *Redlichia* ......in Eastern Asia, Northern India and Australia.' (*Smith. Misc. Coll.*, LIII, 253, 1919.)

and *P. maopensis* and the chief Cambrian fossils of the Salt Range are *Redlichia Noetlingi*, *Hyolithes Wynnei*, *H. Kussakensis*, *Neobolus Warthi*, *Orthis Warthi*, *Botsfordia granulata* and *Pseudotheca Waageni*.

Ordovician Fossils.

Lower Silurian or Ordovician beds have been recognised in Kashmir but, according to Middlemiss (3), the fossil remains are as obscure as in the case of the beds doubtfully placed within the Cambrian. Fossiliferous Ordovician beds have been found in the Central Himalayas and Burma and important monographs have been published containing descriptions of the fossils found from these areas. The first contribution to the knowledge of the Ordovician fossils of the Himalayas was by Salter and Blanford (1) who described General Strachey's collections from Niti. Subsequent to this, Griesbach's Memoir on the Geology of the Central Himalayas (2) was published and in it lower and upper Silurian beds were recognised and they were characterised by marked lithological distinctions. It is now held that Griesbach's correlation of the Palæozoic rocks of the Central Himalayas was faulty and that the beds which were considered by him as ranging from the Silurian to the lower Carboniferous are Ordovician and Silurian in age. Sir Henry Hayden (2) made a detailed study of the Silurian (lower and upper) beds as found in Spiti. The Cambrian fossiliferous beds of the Parahio valley were succeeded by a thickness of unfossiliferous beds which were found to be overlain by a conglomerate taken by Sir Henry Hayden as the base of the Silurian and, between this conglomerate and the fossiliferous Ordovician beds, there is a bed of some 1,500 feet thickness composed chiefly of pinkish red quartzite without any trace of fossils. The fossiliferous Silurian strata are well developed near Muth and, in the Pin valley, eight different horizons have been distinguished of which No. 4 is unfossiliferous. Provisional determination of the fossils was made by Sir Henry Hayden who recognised, among others, *Bythotrephis* cf. *gracilis*, *Halysites catenularia*, *Leptæna rhomboidalis* and *Pentamerus oblongus*. The fossils were entrusted to Dr. Reed who was placed in charge of the materials collected by Strachey, Griesbach, LaTouche and Smith. Dr. Reed's monograph (5) is divided into two parts, and the first part deals with the Ordovician and the second with the Silurian fossils and here we come to the consideration of an important point, namely where to draw the boundary-line between the Ordovician and the Silurian in the Pin valley section. It appears that Sir Henry Hayden was rather indecisive as to the exact line of division between the Ordovician and the Silurian as on p. 27 of his Memoir (2) he writes that 'The

lowest subdivisions (1 to 3) probably include the Caradoc and possibly lower stages,' while in the table at p. 32 of his Memoir the doubtful boundary is shown against horizon 5 and Dr. Reed has included horizons 1 to 5 in his Ordovician and treated the fossils accordingly. A consideration of the question, however, shows that a somewhat different opinion may be held on this point. The Pin valley section is continuous both lithologically and stratigraphically, so to find out a boundary we have to apply to palæontological criteria. No recognisable fossils have been obtained from horizon 4 and not improbably this is due to the dolomitisation of the limestone. If we compare the contents of the horizons (5 to 8) lying above with those of the horizons (1 to 3) lying below this dolomitic zone, certain peculiarities may be observed and these are :—

(i) The presence of *Rafinesquina* in the lower and its absence in the upper horizon.

(ii) The abundance of the Trilobites in the lower and their scarcity in the upper horizons.

(iii) The scarcity of the corals in the lower and their abundance in the upper horizons.

(iv) The presence of the cystoid-like objects in the lower and their absence in the upper horizons.

It may be mentioned that Dr. Reed has described six species of Cephalopoda from the Himalayan Ordovician and two of them (*Cyrtoceras ? sp.*, and *Gonioceras* cf. *anceps*) were obtained from horizon 5 of Spiti, and the others from isolated localities, e.g. *Orthoceras kemas* from Kalajowar, *Orthoceras striatissimum* and *Trocholites juliformis* from the Chorhoti pass and *Cyrtoceras centrifugum* from Rankin. It appears from Dr. Reed's description of the lower Palæozoic fossils of the Central Himalayas that, with the exception of one case, all the Silurian fossils have been obtained from Spiti and the fossils from the other sections, e.g. Chorhoti pass were all from the Ordovician beds. A study of the Chorhoti and Rankin sections shows that the full sequence of beds, namely beds 4 to 8 of Griesbach, was present and, as such, it may be safely concluded that the collections were made from both the Ordovician and the Silurian beds and it is not improbable that the four species of Cephalopods mentioned above which were originally described by Salter are of Silurian age. Reference may be made in this connection to the fossils described by Dr. Reed from the Pethathali valley and it is found that the collection includes some species of *Orthoceras* and *Cyrtoceras* associated with *Calostylis dravidiana* and forms very much like *Strophomena* aff. *wisconsinensis* and thus belonging more to the Silurian than to the Ordovician. From all these considerations I am inclined to propose the following revised classification

of the lower Palæozoic rocks as developed in the Pin valley section :—

8.	*Pentamerus oblongus* zone.	Silurian.
7.	*Orthis basalis var. muthensis* zone.	
6.	*Propora himalaica* zone.	
5.	*Strophomena cf. wisconsinensis* zone.	
4.	No fossils	Passage.
3.	*Apidium indicum* zone.	Ordovician.
2.	*Rafinesquina* zone.	
1.	*Bythotrephis* zone.	

The zone 4 is to be looked upon as a passage bed between the Ordovician and the Silurian. Of the three horizons, horizon 2 is the most fossiliferous. The Spiti Cambrian includes chiefly the Brachiopods, the Pteropods and the Trilobites and in the Himalayan Ordovician all the important invertebrate sub-kingdoms excepting the Protozoa are found represented. It must be mentioned, however, that what were described as cystidian remains by Sir Henry Hayden are found by Dr. Reed as belonging to the genus *Apidium* of doubtful systematic position. It has been pointed out that there is a varying degree of affinity between the Himalayan and the American Ordovician fossils and concluded that the Himalayan fossils belong to the middle Ordovician and have a very close relationship with the beds of the Trenton age. Prof. Grabau (1) has, however, pointed out that 'until more evidence is available it is perhaps better to consider the Spiti fauna as a local one and that its suggestion of American affinities is more apparent than real and due to a certain parallelism in development.' A most important characteristic of the Himalayan Ordovician fauna is the absence of Graptolites and in this respect it resembles the Ordovician (Laripintine) fauna of South Australia and there is no doubt that the Central Himalayan Ordovician and the Laripintine beds belong to the same facies of sedimentation. A connection between the South Australian and the Punjab sea in the Cambrian time has been suggested and it is quite likely that this connection continued during the Ordovician time. The characteristic Himalayan Ordovician fossils are *Graptodictya Griesbachi*, *Dianulites yak*, *Orthis thakil*, *O. testudinaria*, *Triplecia uncata*, *Leptaena trachealis*, *L. halo*, *Strophomena chamærops*, *Rafinesquina aranea*, *R. umbrella*, *Plectambonites himalàyensis*, *Hindella shianensis*, *Asaphus emodi*, *Calymene nivalis*, *Cheirurus mitis*, and *Apidium indicum*.

Let us now pass on to the Ordovician fauna of Burma for a systematic description of which we are also indebted to Dr. Reed. The Burma Ordovician beds were at first recognised by Noetling (1) at a locality about 24 miles distant from Mandalay where he discovered what he thought to be a new species of

Echinosphaerites (*E. Kingi*) associated with a few organic remains and pointed out the Ordovician age of the beds. Subsequently he (2) described these Ordovician beds under the name of the group of Pyinthia limestone with an underlying unfossiliferous group (Mandalay limestone) which was placed under the Cambrian. Messrs. La Touche and Datta, however, succeeded in getting fossils from the Mandalay limestone of Noetling. La Touche included this Mandalay limestone within the lower Silurian and proposed a nomenclature of his own (1), while that proposed by Datta (1) was a little different. Dr. Reed (1) has referred to a classification of the lower Palaeozoic fossiliferous beds of the Northern Shan States proposed by La Touche. It appears from this that the Naungkangyi beds are Ordovician in age. The position of the Nyangbaw beds was left doubtful but the subsequent discovery by La Touche (3) of a section exposing the Silurian Zebingyi beds resting on an eroded surface of the Nyangbaw limestone shows that the latter should be included under the Ordovician. The classification of the Ordovician of the Shan States as proposed by La Touche has been a little modified by Dr. Reed (7) and is as follows :—

<table>
<tr><td rowspan="4">Ordovician ..</td><td colspan="2">Nyangbaw limestone.</td></tr>
<tr><td rowspan="2">Naungkangyi Stage</td><td>Upper (?) Hwe Mawng purples hales.</td></tr>
<tr><td>Lower.</td></tr>
<tr><td colspan="2">Ngwetaung sandstone.</td></tr>
</table>

The Ngwetaung sandstones are very poor in fossils and, besides crinoid stems, contain *Orthis sp.* (cf. *Orthis testudinaria*). The lower Naungkangyi stage is very fossiliferous and chiefly characterised by an abundance of cystoidean remains, while in the upper Naungkangyi stage the Trilobites are supreme. The Nyangbaw limestone contains *Camarocrinus asiaticus,* Reed. A comparison of the fossils of the upper and the lower Naungkangyi beds shows that the genus *Rafinesquina* is confined to the latter. The Cephalopods are very poorly represented in these beds and are only known by two species of *Trocholites*. It has been pointed out that there are more horizons than one in the lower Naungkangyi beds and one of them is represented by the Sedaw limestone with its rich assemblage of the Cystoid remains. According to Reed (8) the Sedaw fauna represents the same stage as that of Shih-tien in Yunan. The Shih-tien fauna indicates a lower-middle Ordovician age and is of interest for its cephalopod remains including *Trocholites Yunnanensis*, Reed, which is very closely related to *T.* cf. *Remelei,* Scroder from the Hwe Mawng beds. According to Dr. Reed the upper Naungkangyi beds correspond to the stage C of the Baltic Province *i.e.* the middle Ordovician; the Sedaw beds, the chief member of the lower Naungkangyi stage, being of an older age as already mentioned. *Camarocrinus asiaticus* has

been found both in the Nyangbaw limestone and the Shih-tien formation, but the *Camarocrinus asiaticus*-bearing beds of Shih-tien are quite distinct from those that have yielded the rest of the fossils and are more like those of Nyangbaw. It has been remarked that the Burma Ordovician shows features of an European element. Prof. Schuchert (1), however, thinks that the Ordovician Naungkangyi (lower) fossils have got some, though rather remote, similarity with the American interior Galena and Trenton formations, thus indicating some apparent relationship between the Ordovician beds of Burma and the Central Himalayas. Bassler (1) has described *Camarocrinus* as being but the root-bulbs of *Scyphocrinus* and the abundance of *Scyphocrinus* in the Nyangbaw limestone is important from this point of view. The presence of Upper Ordovician *Camarocrinus* in Burma and Yunan shows that the animal possibly had its origin in the Burmo-Yunan Ordovician sea. The chief fossils are:—

Protocrinus sparsiporus, Diplotrypa sedavensis, Rafinesquina imbrex, R. subdeltoidea, Plectambonites quinquecostata, Orthis calligramma, O. testudinaria, O. chaungzonensis, O. flabellulum, O. irravadica, O. subcrateroides, Christiania tenuicincta, Modiolopsis Thebawi, Shanina vlastoides, Hyolithes Loczyi, Calymene birmanica, Pliomera ingsangensis, Ogygites birmanicus, Ptychopyge Thebawi, Holometopus wimani. It may be added that, according to Prof. Schuchert (1), the Nyangbaw formation is very closely associated with the Devonian Zebingyi beds palaeontologically.

SILURIAN FOSSILS.

Silurian fossils have been described from Kashmir, the Central Himalayas and Burma. To Mr. Middlemiss (3) belongs the credit of the discovery of the Silurian beds in Kashmir. Fossils were collected from four different localities; a provisional determination was made and an Upper Silurian age was assigned to them chiefly from the position of the beds which were found immediately underlying the Muth quartzite. The fossils were afterwards described by Dr. Reed (5) according to whom at least three of the four localities from which the fossils were collected belong to the same horizon. The same author (9) is of opinion that the age of the fauna is Wenlock. The chief fossils are *Calymene* cf. *Blumenbachi*, *Acidaspis Kashmirica*, *Orthis basalis* var. *elegantula*, *Leptæna rhomboidalis*, and *Plectambonites transversalis*. This fauna, as far as it has been described, shows some Atlantic element.

The question about the division of the lower Palaeozoic rocks of Spiti has already been discussed and it has been pointed out that not unlikely the so-called Ordovician of the Niti area is a mixture of Ordovician and Silurian beds. The Spiti Silurian fossils which do not include any Trilobites are

not numerous and their comparison with the fauna of the Kashmir Silurian shows that the latter corresponds more closely with horizon 7 which is thus of Wenlock age, to which also belongs the horizon 8 and the horizons 5 and 6 possibly represent the Llandovery stage. The chief fossils are *Propora himalaica, Stylarœa kanaurensis, Favosites spitiensis, Halysites catenularia, H. Wallichi, Orthis spitiensis, O. porcata* var, *O. basalis* var., *Pentamerus oblongus* and *Gonioceras* cf. *anceps.*

The Silurian beds of Burma have been classified as below :—

Zebingyi Stage.	
Namhsim Stage.	Kongsha marls. Namhsim sandstone.
Pangsha-pye Stage.	Graptolite band. Trilobite band.

Dr. Reed's earlier monograph on the lower Palaeozoic fossils of the Northern Shan States does not contain any description of the Pangsha-pye Graptolites and the description of the Graptolites in his second monograph (7) is due to Miss Elles. The Graptolites are found at a number of places and it appears that they are not associated with any other class of fossils while, in the beds underlying the graptolite-bearing beds of Pangsha-pye, Corals, Brachiopods, Gastropods and Trilobites have been met with. From an abundance of the trilobitic fauna these underlying beds have been named the Trilobite band. The Graptolite band contains only Graptolites obtained from three different horizons. Mr. Jones (2) has also recorded the occurrence of Graptolites in beds apparently overlying the Hwe Maung purple shales and probably corresponding to the Graptolite band of the Pangsha-pye stage. In his first monograph dealing with the lower Palaeozoic fossils of Burma Dr. Reed (1) did not carry out any sub-division of the Namhsim Stage, but LaTouche (3) proposed a sub-division of the Namhsim Stage into a lower one of sandstone (Namhsim sandstone) and an upper one of marls (Kongsa marls). In his second monograph this classification was adopted by Dr. Reed (7). The lower stage is less fossiliferous than the upper one and contains more of the Trilobites than of any other types of animals. The upper marls show characteristic Silurian fossils like *Leptaena rhomboidalis, Schuchertella pecten, Orthis biloba, O. elegantula, Pentamerus* cf. *oblonga, P.* cf. *galeatus* and *Atrypa reticularis.* The Zebingyi stage is also fossiliferous but very poor in Trilobites and contains Graptolites of undoubted Wenlock stage.

According to the classification given above, the Panghsa-pye Trilobite band is placed at the bottom of the Burma Silurian and succeeded by the Graptolite band in which three horizons have been distinguished. Of these three horizons, the third one with *Monograptus priodon* represents the Wen-

lock stage and the lower one the Llandovery. From a study of the occurrence of the Graptolites as modified by a subsequently published slip of Miss Elles (Reed, 7), it appears very doubtful if the differences between horizons 1 and 2 can be very distinctly maintained. I think it better to recognise only two divisons of the Graptolite band, namely the Ngaitao (lower) and the Kanlun (upper) groups. From the presence of one species (*Dimorphograptus extenuatus*) which is found only in zone 17 of Britain and that of a few species which are also known to range from zone 16 (the very base of the Llandovery) upwards it may be safely concluded that the Graptolite band practically represents the base of the Silurian in this area. According to the scheme outlined above, the Pangsha-pye stage has been divided into two sub-stages but this division which is chiefly a faunistic one may be modified as, according to La Touche (3), Brachiopods are found in a layer immediately below that containing the Trilobites. Thus three sub-stages may be recognised in the Pangsha-pye stage as given below :—

Pangsha-pye stage	Graptolite band. Trilobite band. Brachiopod band.

The Lower Namhsim beds have been correlated with the Wenlock and Upper Namhsim beds with the lower Ludlow. The fossils of the Zebingyi beds are interesting as showing a mixture of Upper Silurian and Lower Devonian types. La Touche has put the beds under Silurian, but Dr. Reed, though agreeing with La Touche, has not failed to point out the transitional character of these beds. The chief fossils are :—

(Graptolite band) *Climacograptus rectangularis*, *Diplograptus modestus*, and *Monograptus tenuis*.

(Trilobite band) *Acidaspis shanensis*, *Phacops* (*Dalmanites*) *Hastingsi*.

(Brachiopod band) *Orthis Mansuyi*, *Schuchertella planissima*.

Namhsim and Zebingyi beds. *Monograptus dubius*, *Lingula Lewisi*, *Orthothetes pecten*, *Mimulus aunglokensis*, *Orthis biloba*, *Atrypa reticularis*, *Modiolopsis shanensis*, *Tentaculites elegans*, *Calymene Blumenbachi*, *Phacops longicaudata* and *Illaenus Namhsimensis*.

DEVONIAN FOSSILS.

In Kashmir, Spiti and the Kumaon Himalayas the Devonian system is mainly represented by the unfossiliferous Muth quartzite which, as pointed out by Sir Thomas Holland (6), may be said to include beds ranging from Ordovician to Devonian. Hayden (2) has, however, described that in the valleys of the Lipak and the Yulang rivers in Kanaur the Muth quartzite

is overlain by a series of siliceous and shaly limestones with four coral-bearing bands which, besides corals, contains crinoids and brachiopods. The corals were identified as a *Cyathophyllum sp.* and, accordingly a Devonian age was assigned to this bed of limestone overlying the Muth quartzite. According to Sir Henry Hayden the fullest development of the Himalayan Upper Palaeozoic is to be seen in the Lipak valley and there the Muth quartzite is overlain by a series of quartzites and limestones overlain by a series of quartzites and shales passing up into conglomerates and calcareous sandstones underlying the Permian 'Productus shales.' According to Hayden the whole sequence is as given below:—

5. Productus shales 4. Calcareous sandstones. 3. Conglomerates, grits and quartzites; passing down into	Permian.
2. An alternating series of shales and quartzites (Po series)	Upper Carboniferous and Culm.
1. Limestone and quartzite of the Lipak river (Lipak series)	Lower Carboniferous and Devonian.

Hayden has described a section of about 2,000 ft., lying between the Muth quartzite and the Po series and this (the Lipak series mentioned above) includes the coral-bearing beds just referred to. The fossils have been studied by Dr. Reed (4) and their Devonian age has been corroborated. Among the fossils the most important are *Orthothetes crenistra* and *O. umbraculum* while one stromatoporid species (*Idiostroma yulangensis*) has also been described. Between this division of limestone and an overlying shaly limestone with an abundance of Lower Carboniferous fossils, there is a thickness of about 600 feet of limestone and quartzite containing only crinoids. The age of these beds is quite indefinite and transitional between the Devonian and the Carboniferous. Fossils of Devonian age have been recorded by Dr. Reed from Byans and include *Atrypa aspera* which is also known to occur in the Spiti area. The Byans fauna suggests a middle Devonian age while the Spiti fauna indicates an upper portion of the Middle Devonian or an Upper Devonian age. This shows that, at least, in these two areas the Muth quartzite does not include the whole of the Devonian as it possibly does in Kashmir.

From these Himalayan beds with very poorly preserved fossils we may now turn our attention to Burma where the richly fossiliferous Devonian beds form the lower section of the Plateau limestone of La Touche (3). The Devonian limestone is extremely dolomitised and, as a rule, does not contain the trace of any other types of fossils, but foraminifera, though, however, rich assemblages of fossils have been found at

Padaukpin (Padaukpin coral-reef) and Wetwin (Wetwin shales) and described by Dr. Reed (2). The Padaukpin fauna is characterised by its richness of corals, bryozoa and brachiopods, *Cyathophyllum* being the most important coral genus recorded. The presence of characteristic fossils like *Calceola sandalina* shows that the Padaukpin fauna belongs to the Middle Devonian or Calceola stage of Western Europe and a careful analysis of the fauna has led Dr. Reed to place it in the uppermost zone of the Calceola stage. The Wetwin fauna is quite distinct from the Padaukpin one and rather poorer. The most abundant group represented in the former is that of the Lamellibranchiata. One ichthyodorulite, possibly the dermal spine of some Acanthoid fish, is also represented. One cutting of the Wetwin shales exposes a section containing *Estheria sp.* as well as very fragmentary plant remains and these, considered along with the evidence afforded by *Echinocaris asiatica* and the ichthyodorulite, show that the deposits might have been estuarine as suggested by Grabau (1). The fauna has been found to resemble that of the Hamilton group (Middle Devonian) of North America. Grabau (1) is, however, of opinion that 'it (the Wetwin fauna) may, however, be a local fauna, developed in early Upper Devonian time from survivors of the Mid-Devonian fauna in the extreme south-western part of the Chinese basin and the resemblance to the American fauna may be more apparent than real.' The relation between the Padaukpin and the Wetwin fossils is not very clear but Dr. Reed thinks that we may regard the Wetwin fossils as of a higher Middle or even Upper Devonian age and possibly they are younger than the Padaukpin fauna. Accordingly we may conclude:—

$$\text{Plateau limestone} \;..\; \begin{cases} \text{Anthracolithic system} \\ \text{Devonian system} \;..\; \begin{cases} \text{Wetwinian.} \\ \text{Padaukpian.} \end{cases} \end{cases}$$

In course of the discussion of the Devonian beds of Asia, Grabau (1) has described the Himalayan Devonian referred to above as being of Upper Devonian age. The fossils that have been recorded from these beds are of a very poor nature, but the only three which have been definitely established, viz., *Atrypa reticularis* var. *desquamata*; *A. aspera* and *Orthothetes umbraculum* are found in Burma and of a distinct middle Devonian age, so the Himalayan fossiliferous Devonian should be included under the middle Devonian and not under the Upper. The chief Devonian fossils from Burma are:—

(*Padaukpin*): *Cyathophyllum ceratites, C. bathycalyx, Hallia striata, Microplasma fractum, Calceola sandalina, Favosites Goldfussi, Alveolites suborbicularis, Aulopora serpens, Heliolites interstinctus, Actinostroma clathratum, Spirorbis omphalodes, Fenestella arthritica, Fenestrapora isolata, Stropheodonta interstrialis* var. *birmanica, Strophonella caudata, Rhynchonella subsignata,*

Atrypa reticularis, Cyrtina heteroclita, Athyris concentrica, Nucleospira lens, Euomphalus Wahlenbergi, Phacops latifrons, and *P. punctatus.*

(*Wetwin*): *Chonetes subcancellata, Nucula Wetwinensis, Bellerophon shanenis* and *Echinocaris asiaticus.*

CARBONIFEROUS, ANTHRACOLITHIC AND PERMIAN FOSSILS (MARINE).

A study of the Carboniferous and the Permian beds in many parts of the world has shown that there are cases where a sharp division between the Carboniferous and the Permian strata is not feasible and to include these Carbo-Permian beds Waagen used the term Anthracolithic (5). So far as the Carboniferous, Anthracolithic and Permian fossils are concerned, two distinct facies may be recognised in India, namely marine and fresh-water. The marine facies is found developed in the Salt Range, Kashmir, Spiti, Kumaon and Burma, while the fresh-water facies includes practically the whole of the lower Gondwana system as given by R. D. Oldham (2).

As the rocks of the marine facies of these formations are typically developed in the Salt Range, it is advisable to start with the fossils found therein. A vast assemblage of fauna has been reported from the Productus limestone beds of the Salt Range and they are underlain by a band of fossiliferous boulder beds—the Conularia beds—which gave rise to an interesting controversy, for a short account of which reference may be made to a paper of Das-Gupta (3). The beds are fossiliferous and the fossils have been described by Waagen (5). More than 20 species of fossils have been described and about half of them are identical with the fossils found in the Lower Marine Series of New South Wales. The fossils of the Productus-limestone have been described by Waagen (2) and are very well known for their richness. Waagen described the rocks as being of Anthracolithic age a view which was also accepted by Oldham (2) with some slight modifications in the minor grouping. Diener (2) in a review of the question of the homotaxis of the Productus limestone beds has pointed out that a large number of Upper Carboniferous fossils is found in the Lower Productus limestone beds and that "The lowest division of the uninterrupted sequence of marine beds, known as Productus limestone, is probably homotaxial with the topmost Carboniferous strata in Europe. The equivalents of the Russian Permo-Carboniferous horizon (Artinskian stage) must be looked for in the middle Productus limestone, but the question whether the boundary between the Permo-Carboniferous horizon with the higher stages of the Permian system ought to have been above the Kalabagh beds, cannot be answered, until cephalopod faunas have been discover-

ed in one of the divisions of the middle Productus limestone." Noetling (5) discovered *Xenaspis carbonaria* in the Kalabagh beds and, according to him, there are no Carboniferous or Carbo-Permian beds in the Salt Range and the only system that is present between the Cambrian and the Trias is the Permian. Tschernyschew (1), however, is of opinion that "the Russian Upper Carboniferous sediments belonging to the Omphalotrochus and Schwagerina horizons have to be considered as homotaxial with the Productus limestones from the Amb beds upwards to the Virgal beds inclusively. The overlying parts of the Productus limestone correspond in all probability with the Permo-Carboniferous of Russia (the Artinskian horizon CPg and the limestone dolomite horizon CPc) and possibly with the lowest horizons of the Permian......As far as our present knowledge allows us to judge the existence of sediments in the Salt Range which are likely to be homotaxial with the upper horizons of the Permian of Russia is highly problematical.

In this correlation the Warcha and the Dandot groups (with *Conularia lævigata* and *Eurydesma globosum*) find their place in the Middle Carboniferous division of the Ural, on the eastern slope of which the conglomerates (possibly of glacial origin) appear to be the equivalents of the Talchir boulder beds of India." The late Mr. Vredenburg in his Summary of the Geology of India (2) proposed a three-fold division of the Productus limestone beds and correlated the whole series as Carbo-Permian, i.e., ranging from Artniskian to Zechstein. While dealing with the homotaxis of the Productus limestone beds of the Salt Range Prof. Grabau (1) has observed that possibly "the Salt Range section is incomplete, and that, while the lower Productus limestone (mostly sandstone) is the equivalent of the Geschellian of Russia, it is separated from the higher members by a disconformity which cuts off the Uralian and possibly the Artinskian so that the middle and upper Productus limestone represents later Permian."

I think that in any scheme regarding the classification of the Productus limestone beds the following important factors should be borne in mind :—

(1) A great similarity between the Amb and the Katta fossils.

(2) The appearance and the great abundance of the Bryozoa in the Virgal and the overlying beds (only one Bryozoon has been recorded from the Amb beds).

(3) The great abundance of the Brachiopods in the Amb, Katta, Virgal and Kalabagh beds where they make up about 66 p.c. of the total fauna.

(4) The presence of *Xenaspis carbonaria* in the Kalabagh beds.

(5) The great drop of the Brachiopods in the Kunda-Ghat

beds where they make up about 36 p.c. of the total fauna.

(6) The presence in the Kund-Ghat and the Jabi beds of ammonites with sutures foreshadowing the ceratite-type of suture-line.

(7) The extreme poverty of the Brachiopods in the Chidru beds where they make up about 10 p.c. of the total fauna. The following remarks of Waagen (5) regarding the Chidru fauna may also be noted :—

> "If we pass in review the species peculiar to the present subdivision (Chidru beds) we find that there are 24 species with palaeozoic and 22 species with mesozoic affinities... These beds can barely any more be called permian; they rather seem to form a transitional stage, a sort of passage beds between the palaeozoic and the mesozoic."

Bearing all these points in mind I think that the Productus-limestone and the underlying Conularia beds may be classified as in the accompanying table. (See chart I.)

The Dandotian is fossiliferous and the fossils were described by Waagen in 3 different papers. Three different fossiliferous horizons were distinguished and they may be designated as the zones of *Hyolithes orientalis* (lower), *Conularia laevigata* (middle) and *Eurydesma globosum* (upper). It has to be pointed out that the zones of *Conularia laevigata* and *Eurydesma globosum* were distinguished by Noetling (5). The fossils found in the middle and the upper division of the Dandot group are very much like the fossils found in the lower marine beds of New South Wales which are Upper Carboniferous. Hence the Dandot group may also be supposed to belong to the upper stage of the Carboniferous. The upper Carboniferous stamp of the Ambian beds has already been pointed out and as there is a complete palæontological break between the Ambian and the Dandotian, I think it more reasonable to put the latter under the middle Carboniferous than under the upper Carboniferous. Recently I have proposed (8) that the age of the Panchet beds should be Permo-Lower Triassic and not lower Triassic as suggested by Dr. Cotter (1) and this evidently means a gradual lowering down of the underlying beds of the Gondwana system so far as their position in the standard stratigraphical scale is concerned. The Talchir beds are thus possibly lower than the upper Carboniferous and this would not be inconsistent with the relegation of the Dandot group to the middle Carboniferous. The chief fossils of the Conularia group are : *Hyolithes orientalis*, *Bucania Warthi*, *Conularia laevigata*, *C. Warthi*, *Discinisca Warthi*, *Serpulites undulatus*, *S. Warthi*, *Eurydesma globosum* and *E. ellipticum*.

Noetling also subdivided the Productus limestone beds into

a number of zones characterised by special fossils as given below:—

CHIDRU GROUP	Zone of *Euphemus indicus* „ „ *Medlicottia Wynnei* „ „ *Bellerophon impressus*
	Zone of *Cyclolobus Oldhami* „ „ *Derbyia hemisphærica* „ „ *Productus lineatus*
VIRGAL GROUP	Zone of *Xenaspis carbonaria*
	Zone of *Lyttonia nobilis* „ „ *Fusulina kattaensis*
AMB GROUP	Zone of *Spirifer marcoui.*

While dealing with the question of zone, the late Sir Archibald Geikie said (Text book of Geology, Vol. II. p. 843, 1903) that "a particular zone or group of strata may be ascertained to be marked by the occurrence in it of various fossils, one or more of which may be distinctive, either from occurring in no other zone or group, or from special abundance in that zone." Hence to designate a particular group of strata under the distinctive name of a certain zone fossil, the ideal case would be to select a species which is both confined to and very common in that zone. The following table of the distribution of Noetling's zone-fossils, however, shows that this ideal condition has not been satisfied in many cases:—

NAME.	Amb.	Katta.	Virgal.	Kala-bagh.	Kund-Ghat.	Jabi.	Chidru.
Euphemus indicus.				v. r	v. c		
Medlicottia Wynnei.					v. r		
Bellerophon impressus.					v. r		
Cyclolobus Oldhami.						v. r	
Derbyia hemisphærica.		c		v. r	c		
Productus lineatus.	r		c	c	r	r	
Xenaspis carbonaria.					r	n. r	
Lyttonia nobilis.			c	c			
Fusulina kattaensis.	c						
Spirifer marcoui.	c	r					

A study of the distribution of the fossils found in the Productus limestone beds as given by Waagen (4) shows that they may better be divided into the following zones:—

Permo-Triassic.	Zone of *Avicula chidruensis* (Chidrubeds).
Jabian.	,, ,, *Strophalosia indica* (Jabi beds). ,, ,, *Euphemus indicus.* (Kund-Ghat beds).
Virgalian.	,, ,, *Spirigerella alata* (Kalabagh beds). ,, ,, *Michelinia indica* (Virgal beds).
Ambian.	,, ,, *Chonetes compressa* (Katta beds). ,, ,, *Spirifer niger* (Amb beds).

The Upper Carboniferous, Carbo-Permian, and Permian beds of the Salt Range are, as well known, extremely fossiliferous. The fossils were elaborately studied by Waagen (2, 4, 5) in a number of memoirs published during 1879–1891. These contributions are of a monumental nature and ranked among the standard works dealing with Upper Palaeozoic palaeo-zoology. The vertebrate life is represented in these beds by piscine remains and all the invertebrate sub-kingdoms are represented though the Arthropoda very poorly. The Ambian is supposed to consist of two sub-groups namely the Amb and the Katta beds. The fauna of the Amb beds consists of 63 species with a preponderance of Brachiopods. Of these 63 species, 45 are confined to these beds and 18 extend into the higher beds. The chief fossils found in the Amb beds are :—

Aviculopecten crebristriatus, Dielesma truncatum, Eumetria grandicosta, Spirifer Marcoui, S. niger, Orthis indica, Chonetis ambiensis, Strophalosia plicosa, S. nodosa, Aulosteges Medlicottianus, Productus cora, P. spiralis, Marginifera ovalis M. echinata, Richthofenia Lawrenciana, Fusulina kattaensis, F. tailensis, and *F. longissima*. The Katta beds have yielded 44 species. The Brachiopods are very abundant, but the genus *Productus* is represented by only one species (*P. gratiosus*) which is rather ubiquitous. Of these 44 species 23 are peculiar to these beds, 5 have continued up from below and do not go beyond, 10 start from these beds and continue to a higher stage and 6 have come up from below and extend into the higher beds. The chief fossils are *Hemiptychina sparsiplicata, Notothyris simplex, Eumetria indica, Streptorhynchus pelargonatus, Leptaena indica, Chonetes compressa, Richthofenia Lawrenciana, and Dybowskiella grandis.*

The Virgalian consists of the Virgal and the Kalabagh beds. The Virgal beds are very fossiliferous and consist of fish fauna as also a large number of Bryozoa and corals besides Brachiopods. Waagen has described 136 species from these beds and of them 62 are confined to these beds, 4 have come up from below and die out here, 52 appear here for the first

time and go upwards, 17 come up from below and extend above, while the position of 1 is doubtful. The chief fossils are: *Hemiptychina himalayensis, H. inflata, Lyttonia nobilis, L. tenuis, Terbratuloidea Davidsoni, Camerophoria purdoni, Spirigerella derbyi, Athyris proyssii, A. capillata, Spirifer musakhelensis, Derbyia grandis, Chonetes squama, C. squamulifera, Chonetella nasuta, Productus lineatus, P. indicus, P. gratiosus, P. abichi, Marginifera typica, Richthofenia Lawrenciana, Polypora megastoma, P. transiens, Synocladia virgulacea, Spirorbis helix, Eocidaris Forbesiana, Cyathocrinus goliathus, Michelinia indica, Geinitzella columnaris, Lonsdaleia salinaria, L. indica, Hexagonella remosa, Dybowskiella grandis,* and *Amblysiphonella vesiculosa.* The Kalabagh beds are also characterised by a fairly large number of fossils, the total number of species recorded being 88. A number of molluscs has been found here and of the total number 15 are peculiar to these beds, 19 have come up from below and disappear here, 20 appear here for the first time and go up and 34 have come up from below and extend upwards. The chief fossils from these beds are *Pseudomonotis garforthensis, Hemiptychina himalayensis, Notothyris subvesicularis, Lyttonia nobilis, L. tenuis, Terbratuloidea Davidsoni, Camerophoria purdoni, Spirigerellă derbyi, S. alata, Athyris roysii, A. capillata, Eumetria grandicosta, Spirifer musakhelensis, Derbyia grandis, Chonetes squamulifera, Chonetella nasuta, Productus lineatus, P. indicus, P. abichi, Marginifera typica, Richthofenia Lawrenciana, Polypora megastoma, Cyathocrinus goliathus, Geinitzella columnaris, Stenopora chaetetiformis, Lonsdaleia indica, Hexagonella remosa* and *Dybowskiella grandis.*

The Jabian consists of the Khund-ghat and the Jabi beds. The Khund-ghat beds are very fossiliferous and have yielded 126 species of which 47 are peculiar to these beds, 24 have come up from the underlying beds and become extinct here, 27 appear in these beds for the first time and continue upwards and 28 have come up from below and extend into the higher beds. The chief fossils are *Microcheilus avellanoides, Pleurotomaria punjabica, Bellerophom jonesianus, B. triangularis, Euphemus indicus, Entalis herculea, Schizodus rotundatus, S. pinguis, Aviculopecten pseudoctenostreon, Oldhamina decipiens, Spirigerella derbyi, Athyris roysii, A. capillata, Streptorhynchus pectiniformis, Derbyia grandis, D. hemisphærica, Chonetes morahensis, C. squamulifera, Chonetella nasuta, Productus indicus, P. abichi, Synocladia virgulacea, Spirorbis helix, Cyathocrinus goliathus, Aræpora ramosa. Geinitzella, columnaris, Stenopora chaetetiformis, Lonsdaleia indica, Hexagonella remosa, Dybowskiella grandis,* and *Margaritina schwageri.* The Jabi beds are specially remarkable for their cephalopod contents from which these beds are also known as the *Cephalopod beds.* Specimens of cephalopods that have been described were obtained chiefly from Jabi and Chidru; a section at the latter

place exhibiting 60 feet of this group consists of brownish or greyish dolomitic sandstones, alternating with marly beds and containing a bed full of ammonites in the lower regions. The beds have yielded 90 species of fossils of which 30 are peculiar to these beds, 53 have come up from below and become extinct here, 4 appear for the first time and go up while 3 have come up from below and extend upwards. The chief fossils are *Cyclolobus Oldhami, Xenaspis carbonaria, Medlicottia primas, Entalis herculea, Oldhamina decipiens, Spirigerella derbyi, S. minuta, Athyris capillata, Streptorhynchus pectiniformis, Chonetes squamulifera, Strophalosia indica, Chonetella nasuta, Productus indicus, P. abichi, Synocladia virgulacea, Arœopora ramosa, Geinitzella columnaris, Hexagonella remosa* and *Dybowskiella grandis.*

The Chidru fauna consists of 63 species of which 43 are peculiar to this group and 20 have come from below. The chief fossils are *Phasianella arenicola, Pleurotomaria sequens, P. punjabica, Margarita prisca, Pleurophorus complanatus, Schizodus dubiiformis, Myophoria prœcox, M. subelegans, Avicula chidruensis, Lucina progenetrix* and *Margaritina schwageri.*

Sir Edwin Pascoe (1) in his description of the geology of Domniwala (Trans-Indus continuation of the Salt Range) has noted the presence of Carboniferous beds in this area. The chief fossils are Brachiopods and Bryozoa. Here 'a mingling of Carboniferous and Trias genera similar to that found in the Salt Range, occurs.'

The existence of the Carboniferous beds in Kashmir has been known for almost a century as the first mention of them is to be found in a writing of Dr. Hugh Falconer in 1838 (1). He was followed by a number of investigators the work of the majority of whom falls outside the time-limit of the present paper. Lyddeker was the first who gave a detailed and systematic account of the geology of Kashmir (7) but many of his observations were subsequently corrected by Mr. Middlemiss (3) who worked out the following sequence of the Carboniferous beds lying between the Muth quartzite and the Zewan beds :—

Gangamopteris beds (Lower Gondwana).
Panjal volcanic flows.
Agglomeratic slate.
Fenestella series (Middle Carboniferous).
Passage beds (Unfossiliferous).
Syringothyris limestone series (Lower Carboniferous).

An account of the Anthracolithic fossils of Kashmir was published in 1899 by Diener (3) and they include species found both in the Fenestella series and the Zewan beds. In this work, the Fenestella series species, however, play a very minor part. In a subsequent work Diener (7) makes a complete separation of the fossils found in the Syringothyris limestone beds, Fenes-

tella series and the Zewan beds. All the Syringothyris limestone fossils which could be identified and described are Brachiopods. A study of the fossils has enabled Prof. Diener to corroborate Mr. Middlemiss regarding the lower Carboniferous age of Syringothyris limestone. The Fenestella series fauna includes Bryozoa, Brachiopods, Pelecypods, Gastropods and Crustacea. Among the Brachiopods the important part is played by Productus and Spirifer. After discussing the relationship of the Fenestella series fossils with the fossils of other areas, Prof. Diener concluded by saying that 'It (the Fenestella series fauna) is certainly older than Permo-Carboniferous, but its correlation with the Lower or with Upper Carboniferous stages is still an open question.' It appears, however, that from the occurrence of *Conularia tenuistriata* in the Fenestella series and from what has already been said regarding the age of the Dandotian beds where *C. tenuistriata* is also met with, we may look upon the Fenestella series as representing the middle Carboniferous stage as already suggested by Mr. Middlemiss.

A reference to the sequence of beds in Kashmir given above shows the presence of agglomeratic slate above the Fenestella series. Mr. Middlemiss found the bed to be unfossiliferous, but as reported by Sir Henry Hayden (4) the late Mr. Bion succeeded in finding out two fossiliferous horizons in it. The results of a detailed study of the fossils have not been published as yet but it has been pointed out by Middlemiss (4) that they may be of Uralian age and that some of the Spirifers discovered in this area are but varieties of an Australian *Spirifer*. The Zewan beds are very rich in fossils which were collected by the late Sir Henry Hayden and Mr. Middlemiss and examined by Prof. Diener (7). The fossils include ichthyodorulitic fragments, Cephalopods (including ammonites) Gastropods, Pelecypods, Brachiopods (constituting about 78 per cent. of the total fauna) Bryozoa, Crinoids and Corals. Middlemiss divided the Zewan beds into a number of horizons but as it has been pointed out by Prof. Diener the zone-fossils cannot be, strictly speaking, considered as such. Thus, for example, the horizon of *Spirifer rajah* is followed by a horizon in which a predominance of the same species is also noticed. Grabau (1) has proposed a zoning of the Zewan beds, and the relationship of these zones with the horizons of Mr. Middlemiss as modified by Prof. Diener is shown below :—

Grabau	Middlemiss (emend. Diener).
4. *Xenaspis carbonaria* zone.	Lamellibranch zone.
3. *Marginifera himalayensis*	*Spirifer rajah* zone. *Marginifera himalayensis.* *Productus semireticulati* section zone.
2. *Protoretepora* zone 1. *Hemiptychina* zone	*Protoretepora zone.*

It may be remarked, in passing, that the ammonite described from the topmost portion of the Zewan beds is *Xenaspis cf. carbonaria* and not *Xenaspis carbonaria* as stated by Prof. Grabau. So far as the faunistic characters of the Zewan beds are concerned we have to note specially (1) the presence of ammonite and the preponderance of lamellibranchs in the lamellibranch zone and (2) the restriction of *Protoretepora ampla* to the lower portion of the section. It appears that a threefold division *i.e.* lower, middle and upper, of the Zewan beds may be worked out, the lamellibranch zone representing the upper, the *Protoretepora ampla* and the underlying zone representing the lower and the intervening beds the middle Zewan. In connection with the question regarding the age of the Zewan beds, the following observations have been made by Prof. Diener :—

(1) 'Faunastically the Zewan beds may be safely considered as a single entity, notwithstanding the possibility of distinguishing several horizons of local stratigraphical value.'

(2) 'The Permian age of the Zewan beds is confirmed by the presence of two Permian species :—

Productus Waagenianus Girty.
Marginifera spinosocostata Ab.'

(3) The evidence of the fauna of the *Protoretepora* zone and of that of the underlying zone 'is opposed to any attempt to claim a lower position in the stratigraphical standard scale for the zone of *Protoretepora ampla* than Permian.'

It appears to me, however, that a different view may be held regarding this question. According to Etheridge (1) *Protoretepora ampla* is a very characteristic upper Carboniferous fossil of New South Wales. In the Spiti area the fossil has been described from the Po series of undoubted upper Carboniferous age as will be shown in the sequel. The occurrence of this fossil in beds of the same age in Spiti and New South Wales has led me to examine the question of the age of the zone of Protoretepora ampla and of that underlying it. According to Prof. Diener the following fossils, besides *Protoretepora ampla*, are found in these two zones :—

1. *Lyttonia nobilis.* 2. *Productus cora.* 3. *P. purdoni.* 4. *P. gangeticus.* 5. *Spirifer fasciger.* 6. *Spirigerella derbyi.* 7. *Camarophoria purdoni.* 8. *Hemiptychina himalayensis.*

Of these 8 species all except *Productus gangeticus* are known to occur in the Salt Range. According to the stratigraphy of the Salt Range, as already proposed, 3 of the species enumerated above are known to begin from the upper Carboniferous, 4 from Carbo-Permian while *P. gangeticus* is known to occur only in the Permian. *Productus waagenianus*, a characteristic Permian form, has been found in the middle of the

section at Mandakpal. This fossil is known to occur in the Lower Permian Guadalupian beds. Thus Mr. Middlemiss' horizon of *Spirifer rajah*, *Marginifera*, *Productus cora*, *Lyttonia*, *etc.*, may be looked on as the starting point of the Permian. From these considerations it follows that the *Protoretepora* zone should not be included in the Permian and that the Zewan beds of Kashmir are not exclusively of Permian age as suggested by Prof. Diener but that they include (?) upper Carboniferous and Carbo-Permian elements also.

Passing from Kashmir we shall turn our attention to Spiti where Griesbach worked out the following sequence in the Pin valley:—

9. Black Productus (Kuling), shales..........Permian.

Unconformity.

8a, Dark flaggy limestone.
8. White quartzite series (Muth quartzite).
7a, Red crinoid limestone
7. Earthy dark-grey limestone.

It has been already shown that the Muth quartzite is Devonian in age and hence only 8a is left to represent the Carboniferous in the Pin valley. The unconformity between the Carboniferous and the Permian is very marked. Regarding this unconformity it has been observed by Griesbach (2) that 'whilst the *Productus* shales are never absent from the base of the Trias, forming with it as it were one great system of beds, they overlap in succession the various horizons of the Carboniferous system in the different areas........The inference therefore is that the permo-trias represents one continuous sequence which overlaps the several horizons of the Carboniferous and that the contact is unconformable.' The late Sir Henry Hayden (1) has also remarked that 'In Spiti the characteristic facies of the upper palaeozoic is the southern of Stoliczka, *viz.* the white (Muth) quartzite overlain by a relatively small thickness of grey limestone, upon which the permian sandstone rests unconformably.' It has, however, been observed by Sir Henry Hayden that a complete section of the carboniferous and permian beds occurs in the valley of the Lipak river. According to him (2) the following table shows the arrangement of the Carboniferous and the Permian beds in Spiti:—

Permian.			Kanaur (Lipak river), upper and lower Spiti (Lisar and Po).	Pin valley, southern and central Spiti.
		"Productus shales."	Black shales with *Xenaspis* and *Cyclolobus* above and *Marginifera himalayensis* below.	Black shales with *Xenaspis* and *Cyclolobus* above, and *Marginifera himalayensis* below.
			Calcareous sandstone with *Spirifer fasciger*, *Spirifer marcoui*, etc.	Calcareous sandstone with *Spirifer fasciger*, *Spirifer marcoui*, etc.
			Grit, quartzite and conglomerate.	
Carboniferous.	(?) Upper	"Po series."	Quartzite and shale (Fenestella shales).	Unconformity.
			Quartzite and shale, with Culm plants.	
	Lower	"Lipak series."	Limestone and thin bands of shale with *Syringothyris cuspidata*, *Productus cora*, etc.	Grey limestone, with *Syringothyris cuspidata*.

A very detailed section (with 7 different beds) of the Lipak series (8a of Griesbach) has been described by Sir Henry Hayden (2) and the account shows the presence of 3 fossiliferous beds, viz. 1, 4 and 6. A preliminary list of the fossils was published by Sir Henry Hayden and a detailed study of them has been carried out by Prof. Diener (4, 7). In the fossils examined there is a preponderance of Brachiopods while fishes, Trilobites, Phyllopods, Cephalopods, Pteropods, Gastropods and Lamellibranchs are also represented. The bed No. 6, has been divided into a number of fossiliferous horizons (a to g), while bed No. 4 consists only of what appears to be crinoids. The bed No. 1, includes 4 bands of corals and other fossils. The coral appears to be *Cyathophyllum sp.*, whilst amongst the other fossils the most important is *Syringothyris cuspidata*, a very characteristic lower Carboniferous form. The fauna of bed 6 is more varied than that just described and includes *Syringothyris cuspidata* thus showing the lower Carboniferous age of the entire Lipak series. The chief fossils are

Estheria sp., *Productus cora*, *P. lineatus*, *Chonetes hardrensis*, *Syringothyris cuspidata*, and *Rhynchonella davreuxiana*. The overlying Po series is known to contain 3 fossiliferous horizons, namely (1) plant beds, (2) black shales with fossil-bearing concretions and (3) Fenestella shales. The plant beds include *Rhacopteris inæquilatera*, a characteristic culm-plant of New South Wales. The second horizon consists of two rows of concretions with an intercalated band of shale. The fossils include *Productus scabriculus*, *P. lineatus*, and *Reticularia lineata*. The fossils from the Fenestella shales have been examined critically by Diener (4, 7) and are supposed to belong to the upper Carboniferous age. The fauna consists of Cephalopods, Pelecypods, Brachiopods and Bryozoa and the abundant species are *Productus scrabiculus*, *P. Nystianus*, *Fenestella. sp. ind. aff. plebeia* and *Protoretepora ampla*. The fauna is of undoubted upper Carboniferous age as suggested by Sir Henry Hayden and Diener. The underlying black shale with fossiliferous concretions is of upper carboniferous age as shown by the absence of *Syringothyris cuspidata* and the presence of *Reticularia lineata*, a characteristic Ambian fossil.

Of the three divisions of the Spiti Permian, the lowest one is unfossiliferous while fossils have been obtained from the other two. Of these two the lower one is less fossiliferous and the chief difference between the two faunae is that the upper fauna contains a number of cephalopods which are entirely absent from the lower fauna. The lower fauna consists of 11 species and of them only three have continued up to the upper part in which about 25 species occur. As regards the correlation of these fossiliferous beds Prof. Diener (4) expresses entire agreement with Dr. Noetling in holding that the upper shales correspond to the Chidru group and the calcareous sandstone to the middle Productus limestone and hence they both belong to the Permian. So far as their correlation with the Productus limestone beds is concerned, Dr. Noetling's conclusion is on a quite sound footing, but as I have been compelled to differ from Dr. Noetling on the position of the different members of the Productus limestone beds in the standard stratigraphical scale, I am inclined to look upon the calcareous sandstone as Artinskian and the Productus shale as Permian.

We have now to turn our attention to the Permian fossils of Kumaon and Garhwal. For a detailed account of the stratigraphy of this region we are indebted to Griesbach (2). The Permian system in this region is represented by a small thickness of 120 to 250 feet and 'forms one of the most important landmarks in the structure of the Central Himalaya.' A number of sections has been described showing, as in Shal-Shal, the lithological continuity and the palæontological break between Productus shales and the overlying Trias. Permian fossils from the Kumaon Himalayas were first of all collected

by General Strachey from the Chorhoti pass and described by Salter and Blanford (1). The next collection from this area is that of Griesbach which was described by Diener (1). Collections were subsequently added to by La Touche and Smith, the former collecting the fossils from the Lissar valley (Johar) and the latter from Byans, from Nihal on the Kuti Yangtu river and from Kana Malla, Kalapani and Lilinthi on the Kali river. These fossils were also described by Diener (4) and the fossils collected from Lilinthi are of extreme importance as they, by their ammonite contents, show the development of a type of Permian fauna not discovered as yet in any other section in Garhwal and Almora. The distribution of the Permian fossils in the Kumaon Himalayas is shown in the accompanying chart (chart II).

The tabular statement as indicated in the chart shows (i) the individuality of the Lilinthi fauna and (ii) the similarity among the faunas of the other areas. Lilinthi fauna is characterised by a number of ammonites which are completely absent from the beds developed in the other Himalayan areas and this is, I think, a distinction quite sufficient to suggest a separation of the Lilinthi fauna from the other Permian faunas of the Kumaon Himalayas. It may be pointed out, in this connection, that according to Prof. Diener (1) 'the fauna of the Productus shales of Kumaon and Garhwal, as represented in Griesbach's Himalayan collection—provided it really belonged to the same stratigraphical system, should be considered of permian rather than of permo-carboniferous age, although the palaeontological evidence alone does not appear sufficient to decide the question.'

The Lilinthi fauna appears to have a great similarity, as already pointed out by Prof. Diener, with the Permian Fusulina limestone of Sicily so far as the cephalopods are concerned, and this similarity would lead us to put the Lilinthi fauna as being homotaxial with the Fusulina limestone of Sicily which is of lower Permian age. It may be pointed out, however, that the strongly trachyostrac nature of the genus *Lilinthiceras* is more in favour of an age younger than that of the Fusulina limestone of Sicily and I am inclined to put the Lilinthi fauna as representing the upper Permian age foreshadowing the incoming of the trachyostrac ammonites of the Triassic time. Hence we may conclude that, in the Himalayan Permian, two stages are present—a lower and an upper. The lower stage is more extensively developed and has a large number of fossils while the upper stage is developed at only one locality, i.e. Lilinthi and the fossils found therein are not quite numerous. The lower and the upper stages of the Himalayan Permian may, accordingly, be styled the Johar stage and the Lilinthi stage respectively. It may be pointed out that the detection of a fauna with an aspect decidedly

newer than that of the Fusulina limestone of Sicily is more in accord with the fact that the Himalayan Permian gradually passes into the overlying Triassic *Otoceras Woodwardi* zone. Griesbach (2) has recorded indistinct plant impressions in the Permian shales of the Himalayas. The chief fossils from the Permian rocks of the Himalayas are *Chonetes Vishnu*, *C. lissarensis*, *C. transitionis*, *Productus gangeticus*, *P. cancriniformis*, *Marginifera himalayenis*, *Spirifer rajah*, *S. fasciger*, *Spirigerella derbyi*, *Spirigera Gerardi*, *Dielasma La Touchei*, and *Aviculopecten hiemalis*.

Attention may be drawn, in this connection, to the discovery of a number of fossiliferous boulders at the mouth of the Subansiri gorge in Upper Assam by Dr. Maclaren (1). The fossils which are of Carbo-Permian age were provisionally determined by Dr. Maclaren and subsequently examined by Prof. Diener (5). Among the fossils the casts of *Chonetes cf. carbonifera* Keyserling are the most abundant, but the most interesting find is the discovery of *Fenestella sp. ind. aff. plebeia* McCoy from these Assam boulders as the genus *Fenestella* has not hitherto been recorded from the Kumaon Himalayas. Neither the scanty fossils nor the boulders throw any light on the source of the fossiliferous blocks and regarding this point the following observation has been recorded by Dr. Maclaren :—

'It (the locus of the fossiliferous bed) may possibly be looked for at the base of the Damuda Series at no very great distance from the Assam plain, along the probable continuation ....of those rocks..............but, from our recently acquired knowledge of the extension of the younger Spiti shales along the northern flank of the gneisses and metamorphics of the Himalayas, it seems also possible that these fossils have been brought from the headwaters of the Subansiri, which, as far as our knowledge of its course goes, appears to cut through the main chain and have its sources on the edge of the Tibetan plateau.'

Turning towards Burma we find that Tenasserim is the locality from which upper Carboniferous fossils were first recorded. The fossils were first discovered by Mr. P. N. Bose (1) who described the geology of the area and gave the name of Moulmein group to the beds containing the fossils which he regarded as belonging to the Upper Carboniferous period. According to Dr. Noetling (3) the fauna shows a mixture of the Salt Range and the Sumatran types. The fossils most abundant are *Schwagerina Oldhami* and *Lithostrotion n.sp. aff. affine*. The Moulmein group which is probably of varied age ranging from Silurian to Anthracolithic is, however, very poor in its fossil contents, but there is an abundance of the Anthracolithic fauna in the Shan States and their neighbourhood. While dealing with the Devonian fauna of Burma reference was made to the two-fold division of the Plateau limestone and let us now

turn our attention to the upper part of this division, i.e. the Anthracolithic. To Mr. Middlemiss (1) belongs the credit of the first discovery of the Upper Palaeozoic fossils in the Southern Shan States area, while Datta (1) discovered the first trace of Anthracolithic life in the Northern Shan States. Anthracolithic fossils from three different localities, Keshi Mansam, Namun and Mong Pawn, have been described by Prof. Diener (6) who has pointed out that the facies of the fossils found in the different localities are varied. The Keshi Mansam Fusulina limestone which is the most prolific in fossils is marked by an abundance of Brachiopoda as in the Himalayas. Prof. Diener has also drawn attention to the fact that the species found in this limestone are all of a small size so much so that 'among the *Productidae* not only all the large species of the *semiretuticulati* group, which are the most characteristic leading forms of the Productus limestone in the Salt Range, are absent, but even *Productus cora*, the most common species in the Keshi Mansam, never grows to such large dimensions as in the Salt Range, in Russia or in South America.' The Brachiopods also predominate in the Nammu fauna which is also characterised by a large number of Bryozoa (including *Fenestella*), while the fauna from Mong Pawn is more allied to Namun than to the Keshi Mansam fossils. The fauna contains no trace of any Cephalopod and has been supposed by Prof. Diener to agree with the Middle and the Upper Productus limestone of the Salt Range. It may be added in passing that the Rhaetic (Napeng) and the Jurassic (Namayu) stages of the Shan States have also hitherto been found to be quite barren of cephalopods. The most important Shan States Anthracolithic fossils are: *Spirifer fasciger*, *Martiniopsis LaTouchei*, *Hustedia remota*, *Streptorhynchus shanensis*, *Productus cora*, *P. abichi*, *Strophalosia costata*, *Fusulina elongta*, *Schizophoria indica*, *Notothyris nucleolus*, *Hexagonella remosa*, *Spirigerella Derbyi* and *Chonetes grandicosta*.

An account of the marine Anthracolithic fauna of India is incomplete if no reference is made to Mr. Sinor's discovery at Umaria in Central India. The fossils which are mainly belonging to the genus *Productus* were at first publicly exhibited at the Geological Section of the Indian Science Congress held at Madras in 1922. A short account of the discovery was published by Dr. Fermor (2), while a general description of the section was published by Mr. Sinor (1) subsequently. The fossils have been entrusted to Dr. Reed for description. The results of Dr. Reed's study have not been published yet, but according to Sir Edwin Pascoe (4), the fauna has a peculiarity of its own and is closer to the Permian than to the Carboniferous fauna of other areas. A few years ago I had an opportunity of visiting this fossiliferous section. The beds lie between the metamorphics and the Barakars and were marked as Talchir by Hughes (1).

The rocks are swarmed with shells of *Productus*. While extracting the fossils from their matrix Mr. S. C. Chatterjee, a post-graduate student of the Calcutta University, succeeded in obtaining a very nicely preserved Gastropod considered by him as a close ally of, if not identical with, *Lophospira*.

ANTHRACOLITHIC FOSSILS (FRESH WATER).

The rocks that are to be described under this section are those forming the lower division of the Gondwana system which, though chiefly remarkable for its palaeobotanical richness, is not completely wanting in animal remains. The palaeobotanical contributions, so far as the Gondwana beds are concerned, are chiefly due to Feistmantel, who may be looked upon as the founder of Indian palaeobotany, and though a great portion of his work was published during the period prior to that dealt with in this paper quite a good amount of palaeobotanical work was also done by him subsequent to 1877. In 1881 he (1) published a sketch of the Gondwana fossils. The animal fossils are chiefly of the vertebrate type and, during the period under review, Lydekker contributed a number of papers to elucidate them. But before proceeding with an account of the fossils, it is necessary to deal with the homotaxis of the Gondwana beds just to fix accurately the limits to go beyond which will be outside the scope of the present address. The question of the homotaxis of the Gondwana beds was discussed by Dr. T. Oldham (1) and, according to him, the Talchir and the Damuda divisions represent an upper Palaeozoic time. In the first edition of the Manual of the Geology of India Medlicott and Blanford (1) recognised two divisions of the Gondwana system—lower and upper—and the whole of the lower Gondwana was doubtfully referred to the Paleaozoic. The lower division, it may be pointed out included beds from Talchir to Panchet. Attention may be drawn, in the connection, to the address delivered by Blanford (1) as the President of the Geology Section of the British Association in which he tried to show that the ages assigned to the Gondwana beds on the floral and the faunal evidence were contradictory as beds with Triassic fauna were found to overlie beds with a Rhaetic or Jurassic flora. As a result of the advance Palaeontology has made in course of the nearly half a century that has passed since, we now know that the contradiction does not exist and that the floral and the faunal evidences fairly tally with each other. From the evidence of the vertebrate remains Lydekker (9) came to the conclusion that the Bijori and the Mangli beds were of Permian and the Panchets of lower Triassic age. Subsequently Lydekker (10) pointed out that the Bijori and the Mangli beds might be taken to represent the upper Damuda beds and that the Barakars agreed with the lower Permian or upper Carboniferous and the

Talchir either with the upper or the lower Carboniferous. Dr. Waagen (3) doubtfully correlated the Panchet with the lower Triassic and put the pre-Panchet Gondwanas as ranging from the upper Carboniferous to Permian. In the second edition of the Manual of Indian Geology Mr. Oldham (2) had the two-fold classification of the Gondwanas and the lower Gondwana was assigned to upper Carboniferous—Triassic age.

It may be pointed out that side by side with this conception of the two-fold subdivision of the Gondwana system, there also sprang up the idea of subdividing the system on a three-fold basis. Mr. Vredenburg (2) followed this three-fold division and his middle division included (1) Panchet, (2) Kamthi and (3) Maleri. At the meeting of the first Session of the Indian Science Congress Das-Gupta (2) pointed out that an attempt to separate the Panchet from the lower Gondwana beds was not warranted by palaeobotanical considerations and that the relative position of the Panchet and the Kamthis as proposed by Mr. Vredenburg was not correct. It was suggested that the Kamthis were older than the Panchets and represented very likely the upper portion of the Raniganj beds. It is interesting to note that according to Sir Edwin Pascoe (2) subsequent discovery of fossils in the Siliwora-Kamthi area corroborated this view. Dr. Cotter (1) has proposed a revised classification of the Gondwanas in which a lower Triassic age has been assigned to the Panchet beds and the same opinion appears to be maintained by Dr. Baker (1) according to whom the Panchet and the Mahadeva are Triassic in age. Very recently I (8) have given my reasons for holding an opinion a little different from that of Dr. Cotter and ascribed an upper Permian to lower Triassic age to the Panchet beds. Accordingly, in this address my remarks will be extended up to the fossils found in the Panchet beds.

The fossils that are found in the lower Gondwana belong chiefly to the vegetable kingdom and the types of animal fossils found are very poor in number. Allusion has already been made to the paper published by Feistmantel in 1881 and very few additions have been made since then to our knowledge of these lower Gondwana fossil plants. In 1882 the South Rewa Gondwana fossil plants were described by Feistmantel (2) and they included some lower Gondwana species all of which were previously known. The flora of the Daltongange and the Hutar coal-fields described by Feistmantel (3) did not reveal any new species and in 1886 Feistmantel (4) described some fossil plants from Karanpura, Auranga, Hutar, Daltongange, Ramkola, Tatapani and South Rewa. A systematic review of the fossils of the lower Gondwana is also to be found in this contribution. In the year 1897 Mr. R. D. Oldham (3) announced the discovery of *Glossopteris* with a portion of its rhizome attached, the rhizome being recognisable as a *Vertebraria* suggesting the

transfer of this genus from the Equisetales to the Pteridospermae. It may be pointed out that a similar discovery was also made by Zeiller (1) almost simultaneously though Oldham and Zeiller were not agreed about the interpretation of the origin of the structure observed in *Vertebraria*. A short monograph on the lower Gondwana plants was contributed by the late Dr. Zeiller (2) and it includes the description of *Feistmantelia bengalensis* subsequently changed into *Ottokaria bengalensis* which has been described by Profs. Seward and Sahni (1) as the cupular investment of a seed belonging to some seed-bearing Pteridosperm shoot. Two other species of *Ottokaria* have since been described by Thomas (1), one (*Ottokaria ovalis*) from Brazil and the other (*Ottokaria Leslii*) from South Africa.

It appears from Arber's (1) critical study of the lower Gondwana plants that some 55 species of fossil plants occur in the lower Gondwana beds i.e., beds ranging from the Talchir to the Panchet. Seward and Sahni (1) have revised the Gondwana plants, both lower and upper, and introduced a few generic names new to science. Stems of *Dadoxylon* have been described from the Deoghar coal-field by Miss Holden (1) and from the Asansol coal-field by Bradshaw and Sahni (1). The specimens found at Asansol are of a huge size and show well defined circular markings which may represent annual rings and go to support the opinion held by many that the climatic changes were introduced in the Southern Hemisphere much earlier than in the Northern Hemisphere. With the help of the comparatively recent method of the study of the cuticles, it has been established by Prof. Sahni (2) that *Glossopteris indica* and *Glossopteris angustifolia* are specifically distinct.

Seward and Sahni (1) have identified *Bothrodendron sp.* comparable to *B. Leslii* found in the South African Carbo-Permian beds and the presence of the genus is an evidence of the migration of a northern genus to the Southern Continent. Instances of such migrations have been known outside India also and attention may be drawn in this connection to *Actinopteris bengalensis* found in the Raniganj beds which, as already suggested by Prof. Zeiller (2), should be regarded more as belonging to an Equisetales than to any other class and comparable to *Annularia* and *Astrophyllites equisetiformis* in a general way. *Cordaicarpus* sp. cf. *C. Cordai* described by Seward and Sahni from the Karharbari beds of India has been looked upon by the authors as an instance 'of the close resemblance between certain members of the Glossopteris flora and plants that were already spread in the northern-hemisphere.' Reference may be made, 'in this connection' to the occurrence of Calamites (?) in the Carbo-Permian beds of Yunan as described by Dr. Reed (10). It may not be out of place to refer here to a paper by Dr. Walkom (1) who described the genus *Nummulospermum* supposed to be a probable megasporangium of

Glossopteris. After a full consideration of the types of plants associated with this platyspermic (?) seed (*N. Bowenense*), the author concluded that the seed belonged to species of *Glossopteris* and recorded the following observations :—

'Although we have advanced a stage in our knowledge of *Glossopteris*, there is still much to be learnt. The Megassporangia show that the genus belongs either to the Cycadofilicales or to the Cordaitles, which two groups cannot be separated on the evidence of their seeds alone. If we take into account other features in connection with *Glossopteris*, the balance of evidence appears to be in favour of its reference to the Cycadofilicales. The association of scale-fronds and perhaps the venation of the leaves support this; further, if we accept *Vertebraria* as being the underground rhizome of *Glossopteris*, the indication is that it belongs to the Cycadofilicales rather than to the Cordaitales........

We have next to consider to which group of the Cycadofilicales the seeds described above as *Nummulospermum* belong....

The anatomical features then, so far as they can be made out with any degree of certainty, appear to favour the reference of this genus to the Trigonocarpales.'

It may be mentioned that impressions of seeds have also been known from the lower Gondwanas for a long time and that they are almost exclusively confined to the Karharbari beds where *Ottokaria bengalensis* and *Arberia indica* have also been met with.

The poverty of the lower Gondwana beds in their contents of animal fossils has already been referred to. In the earlier years Owen and Huxley contributed important papers towards the elucidation of the fossil animals, chiefly those found in the Panchet beds, but they are not noted here on account of the time-limit, as they were all published prior to 1877. The lower Gondwana fauna belongs to the reptiles, amphibia, fish and crustacea. The reptiles obtained from these beds are extremely interesting and belong to the Stegocephalia, the Dicynodonts, and the Dinosauria. During the period under notice Lydekker (1) described, besides *Lystrosaurus orientalis*, a (?) new species of *Lystrosaurus* and a coracoid (?) of *Ankistrodon* subsequently changed into *Epicampodon* by him (11). It was pointed out, however, by Lydekker (13) that the coracoid referred to the dinosaurian *Epicampodon* really belonged to *Lystrosaurus* and that the previously published description of *Lystrosaurus orientalis* needed some corrections. Das-Gupta (4) pointed out that there was no evidence of the presence of a second species of *Lystrosaurus* in the Panchet beds, while later on he (7) described a dinosaurian coracoid possibly belonging to *Epicampodon*. In a very recent communication a megalosaurian tooth and a stegocephalian vertebra (?) have been described by him (8). So far as the Amphibia are con-

cerned, Lydekker (1) described from the Panchet beds certain additional parts of *Gonioglyptus longirostris* and *Pachygonia incurvata* as also (3) a new type of Labyrinthodont mandible named *Glyptognathus fragilis* by him afterwards (4). A fairly well-preserved labyrinthodont skull with parts of the axial skeleton from the Bijori beds was described by Lydekker (8), while a short note on the same subject was published by him earlier (5). The fossil has been named *Gondwanosaurus bijoriensis*. Das-Gupta (7) has described a part of a cranium possibly belonging to *Pachygonia incurvata* while it has been suggested by him (8) that likely this animal was of an archaic type with vomero-palatine teeth developed. The fish fauna has been described by Miall (1). The only crustacean remnant found during this period is a fragment of a (?) brachyurous crab described by Das-Gupta (7). The chief plant fossils of the Lower Gondwana beds are:—[1]

(Panchet)—*Glossopteris angustifolia, G. indica, Thinnfeldia odontopteroides*, and *Schizoneura gondwanensis*.

(Raniganj)—*Glossopteris Browniana, G. retifera, G. angustifolia, G. indica, G. ampla, Rhipidopsis densinervis, Palaeovittaria Kurzi, Belemnopteris Wood-Masoniana, Merianopteris major, Sphenopteris Hughesi, S. polymorpha, Phyllotheca indica, Schizoneura gondwanensis, Cladophlebis Roylei, Cordaites (Nœggerathiopsis) Hislopi*, and *Sphenophgllum speciosum*.

(Iron-stone shales)—*Glossopteris indica, G. ampla, Gangamoptersis cyclopteroides*, and *Cordaites (Nœggerathiopsis) Hislopi*.

(Barakar)—*Glossopteris ampla, G. retifera, G. indica, Gangamopteris cyclopteroides, Sphenopteris polymorpha, Schizoneura gondwanensis, Cordaites (Nœggerathiopsis) Hislopi*, and *Sphenophyllum speciosum*.

(Karharbari)—*Glossopteris indica, Gangamopteries cyclopteroides, Gondwanidium (Neuropteridium) validum*[2], *Buriadia heterophylla, Samaropsis Milleri, Cordaites (Nœggeralhiopsis) Hislopi, Cordaites (Nœggerathiopsis) Whittiana*, and *Schizoneura gondwanensis*.

(Talchir)—*Glossopteris indica, Gangamopteris cyclopteroides, Cordaites (Nœggerathiopsis) Hislopi*, and *Schizoneura gondwanensis*.

The lower Gondwana beds are almost confined to the peninsular portion of India, but in 1903 Sir Thomas Holland (4) referred to the discovery of *Gangamopteris* and a few other fossils at Khunmu in the Vihi valley of Kashmir in beds ap-

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[1] For a full list of these fossils see Sahni (1).

[2] For the use of the generic name *Gondwanidium* see Abh. Senekenberg, Naturfor. Gesellsch, Bd. XXXIX, Heft 3. p. 342, 1927.

parently below the Permian marine strata. These fossils were subsequently described by Seward and Smith-Woodward (1), the former being responsible for the description of the flora and the latter for that of the fauna. The fauna includes remains of labyrinthodonts and fish. A detailed account of these fossiliferous beds was published by the late Sir Henry Hayden (3) and Prof. Seward (1) contributed a short note dealing with the fossil plants collected by Sir Henry Hayden. This was followed by another note on the fossils of these beds by the present author (1). The note includes the description of a part of the skeleton of a fish. Very important additions have been made by Mr. Middlemiss (2, 3) to our knowledge of the Kashmir Gondwana beds. According to him, the Kashmir Gondwanas occupy a position below the Zewan beds. Subsequently Prof. Seward (2) described the lower Gondwana plants from the Golabgarh Pass in Kashmir. Middlemiss (4) has put the Kashmir plant-bearing beds under the Artinskian age. Prof. B. K. Bose (1) has quite recently described the occurrence of lower Gondwana plant remains in a new locality in Kashmir, namely the Bren Hill. The Kashmir Gondwana fossils include the following chief forms :—

Gangamopteris kashmiriensis, *Glossopteris indica*, *Cordaites Hislopi* and *Psygmophyllum Haydeni*.

Conclusion.

I have almost finished that I desired to speak about and I am afraid that I have been compelled to exceed the limitations of both time and space set to the Presidential speech by the authorities of the Congress. I said at the beginning of my address that we were now living in that period of the development of the geological science when, in Europe (as also in North America), the whole work was being carried on by the State Departments of Geological Survey, Universities and Geological Societies. All the advances made in our knowledge of the pre-Mesozoic Indian fossils as outlined above and for the matter of that in all departments of Geology in India are chiefly due to the work of the Indian Geological Survey and the shares borne by the State Geological Departments (with one notable exception), learned Societies and the Universities are very insignificant. There are a few Indian States with geological departments of their own and they are mainly concerned with the questions of an economic nature. There are, at present, two Societies in India devoted exclusively to the discussion of problems connected with Geology and the allied branches of human knowledge. The Senior of these two Societies has got a record of good work to its credit. The authorities of the Junior Society, the very recently started Geological, Mining and Metallurgical Society of India, are also quite hope-

ful of its future in spite of what others might think to the contrary. It is unfortunate that Geology as a science has not had the same amount of encouragement at the hands of the University authorities as one might have expected. Thus we find that there are many Indian Universities where Geology is not taught at all; and even in those Universities where it is taught, the teaching is confined to one Institution only as a rule. It may also be pointed out that in some of the Institutions where geology is taught the strength of the teaching staff is rather limited. It is true that the University people are now trying to participate in the Geological researches that are being carried on in the country, but on account of the causes mentioned just now, the amount of the work turned out by them has been very small indeed. Both in this country and outside, the general public apparently fail to realise the importance of Geology as a pure Science and this is possibly the reason why in 1925 Prof. Parks (1), while addressing the Geology Section of the British Association for the Advancement of Science, selected 'Cultural aspects in Geology' as his subject of address and said 'The Science of Geology is wide in scope and general in application; it deals with matter and life, with time and space; it touches the philosophical and borders on the romantic; majesty and beauty are its essentials and imagination is necessary for its pursuit. The cultural value of such a Science is not to be despised.'

My most revered teacher Sir Thomas Holland (7) in course of his address as the President of the Section of Educational Science of the British Associaton for the Advancement of Science held in 1926 also pointed out the neglect that was being shown to the departments of Science connected with a knowledge of nature and laid a special stress on Geology. We thus find him saying, 'In the old days when Sir Richard Gregory and I were together at South Kensington, a student could not obtain a College full diploma in any subject not even in Mathematics and Mechanic without passing through part one of Geology.......Huxley and his colleagues believed that every man ought to know something of the history and the origin of the features of the only world on which we live in human form; and that without an acquaintance with those branches of Science which are more observational than experimental no man could be regarded as an educated man. Geology is optional not a compulsory foundation subject at South Kensington. The Imperial College has yielded to outside influences and the pressure which has followed the abnormal growth of each Science with consequent demand for more time to be given to the final schools. Possibly, we now turn out better Chemists, more specialised Mathematicians and more efficient Physicists than we did in the old days but we imagine that we run the risk of producing less valuable citizens who are relat-

ively happy only because they are blind to the beauties of the world around them.'

Extremely significant words are these coming as they do from one who is a great scientific investigator, a very successful teacher of students and a capable administrator. It is to be hoped that the educational authorities in India will ponder over the addresses of Prof. Parks and Sir Thomas Holland just referred to and give to the subject of Geology a place in the courses of the University Studies that rightly belongs to it, equip the Geology departments well with men and money and afford facilities to the teachers that they may carry on their two-fold duty of training up the students and carrying on research. Hopeful indications are already on the horizon and I am quite confident that if the University and other educational authorities do not fail to encourage the teachers of Geology in every possible way, the teachers will also not fail, in their turn, to contribute their quota to the investigation of the geological problems of this country.

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Chart I.

CLASSIFICATION AND CORRELATION OF THE UPPER PALÆOZOIC BEDS OF THE SALT RANGE.

WAAGEN (1891).			OLDHAM (1893).		NOETLING (1901).			TSCHERNYSCHEW (1902).	VREDENBURG (1910)	DAS-GUPTA (1928).	ZONE-FOSSILS OF THE SALT RANGE ACCORDING TO DAS-GUPTA (1928).	
Upper Productus Limestone.	Chidru Beds. Jabi Beds. Khund-Ghat Beds.	Permian (a).	Chidru Group. Upper.	Productus Beds.	Chidru Group.	Thuringian Stage (Zechstein).	Permian.	Lower Permian Limestone-Dolomite Horizon CPc. And Artinsk Bed CPg.	Zechstein.	Permo-Triassic. Permian (Jabian).	*Avicula chidruensis* (Chidru Beds). *Strophalosia indica* (Jabi Beds). *Euphemus indicus* (Kund Ghat Beds).	Chidru. Jabian.
Middle Productus Limestone.	Kalabagh Beds. Virgal Beds. Katta Beds.		Middle.		Virgal Group.			Schwagerina Horizon.	Rothliegende.	Artinskian (Virgalian).	*Spirigerella alatus* (Kalabagh Beds). *Michelinia indica* (Virgal Beds).	Virgalian.
Lower Productus Limestone. (Upper Speckled Sandstone.)	Amb Beds.	? Lowest Permian or Topmost Carboniferous.	Lower.		Amb Group.			Cora Horizon (b) Omphalotrochus Horizon.	Artinsk.	Upper Carboniferous (Ambian).	*Chonetes compressa* (Katta Beds). *Spirifer niger* (Amb Beds).	Ambian.
Middle Speckled Sandstone.					Warcha Group.	Punjab Stage (Rothliegende).		Middle Carboniferous.	Upper Uralian.	Warchian.	Middle Carboniferous.	
Boulder Bed.					Dandote Group.			Conglomerate and Breccias on the eastern slope of the Ural.		Dandotean.		
Lower Shales (?)					Talchir Group.					Talchir.		

(a) In the text (Geological Results IV, p. 190) Waagen, while describing the fossils from the middle division of the middle Productus limestone, has recorded the following observation:—

'It appears very clearly that the relations of the faunæ of the middle division of the middle Productus limestone are much more intimate with the faunæ following above than those preceding it....

Thus it is apparently a chief boundary line that extends between the middle and the lower divisions of the middle productus—limestone, and I am inclined to draw here the limit between the permian and the permo-carboniferous formations.'

(b) It may be pointed out that in the Salt Range *Productus Cora* is confined to the Amb group.

Chart II.

DISTRIBUTION OF THE PERMIAN FOSSILS OF THE KUMAON HIMALAYAS.

NAME.	S.W. Niti Pass.	Chorhoti Pass.	Johar.	Nihal.	Kanamalla.	Kalapani.	Lilinthi.
Chonetes vishnu ..	×	×					
Chonetes lissarensis ..			×	×		×	
Chonetes cf. uralica ..			×				
Chonetes transitionis ..				×			
Productus purdoni ..	×		× ?				
Productus gangeticus ..	×	× ?	× ?			× ?	
Productus cf. serialis ..	×	× ?					
Productus cf. cancrini ..	×						
Productus cancriniformis	×			×			
Spirifer ravana ..	×		×	× ?			
Spirifer fasciger ..	×		×	×		×	×
Spirifer nitiensis ..	×		×				
Spirifer joharensis ..			×				
Spirifer rajah ..			×			×	
Spirifer bambadhurensis			×				
Spirigera Gerardi ..	×	×	×				× ?
Spirigerella derbyi ..	×						
Martinia glabra ..	×						
Marginifera himalayensis			×	×	×	×	×
Dielasma La Touchei ..			×		× ?		
Aviculopecten hiemalis ..	×	×					
Leibea aff. Hausmanni ..						×	
Leda cf. speluncaria ..				×		×	
Pleurotomaria cf. punjabica			×	× ?			
Hyattoceras n. sp. affi. cumninsi							×
Adrianites sp. ..							×
Gastrioceras aff. marianum							×
Pericyclus sp ..							×
Lilinthiceras sp. ..							×
Brancoceras sp. ..							×
Nomismoceras Smithii ..							×

Section of Geology.

Abstracts.

1. A field method for the determination of specific gravity.

D. C. NAG, Calcutta.

A simple and quick method of field examination of crude ore-samples by means of an ordinary drawing scale and examples of estimation of minerals from their specific gravities determined by the scale. Confirmative chemical analyses.

2. Crystallographic notes.

S. L. BISWAS *and* B. N. MAITRA, Calcutta.

Description of a crystal of Quartz from Singbhum, showing basal pinacoid and of crystals of Zeolites, Calcite and Aragonite from the Deccan Trap.

3. An occurrence of a tin deposit in Gaya district.

D. C. NAG.

Short history of the tin deposits and their economic aspect: Geology and special features of the present deposit—Mineralisation—associated minerals—Micro-granular structure. Genesis—association with eruptive rocks—evidence of pneumatolysis. How it differs from most pegmatitic deposits. Results of chemical analyses of the associated dykes, tourmaline, and typical ore-samples. Findings from microscopic examination of slides, and micro-chemical examination of samples. Order of crystallisation of ore-minerals and possibility of extension of cassiterite in depth. The micro-brecciation of the garnet-cassiterite rock and the condition under which it was formed. Section of one of the veins showing lateral distribution of tin and tungsten minerals. Occurrence of a copper deposit in the neighbourhood associated with plenty of magnetite exhibiting a very strong polarity—its possible relation to the tin deposit.

4. Ilmenite and titaniferous iron ore from Nellore District, Madras.

V. S. SWAMINATHAN, Madras.

Ilmenite occurs in the form of large segregated masses in a pegmatite vein, situated a mile N.E. of Gulimcherla village, Rapur Tq. The associated minerals are felspar and biotite. Individual masses often weigh 30-50 lbs. The mineral breaks up easily into thin plates and tabular pieces, and the freshly broken surface reveals a submetallic lustre. The sample gives, on analysis, 49·82% of TiO_2.

The mineral is available in fairly large quantities and could, with profit, be exploited, as it is extensively used in the manufacture of ferro-titanium alloys and titanium-white.

Titaniferous iron ore is met with in limited quantities closely associated with another pegmatitic vein near the Patragunta mica-mine (Gudur Tq.). The specimens are tabular and have a dull steel-grey lustre.

The results of the analysis of the mineral are given :—

SiO_2·	TiO_2·	Al_2O_3·	Fe_2O_3·	FeO·	MnO·	MgO·	CaO·	P_2O_5·	Total.
0·65	28·71	0·48	—	67·71	1·89	0·90	Nil	Nil	100·34

Only very limited quantities of the mineral are available.

5. Notes on the iron ore of Mandi State.

S. K. Roy, Mandi.

The unfossiliferous Krol slates of the Mandi state are characterised by the presence of a magnetite-chlorite-schist in which, at certain places, magnetite attains such an enrichment that the rock may then be considered as an iron ore, *magnetite-haematite-quartz schist.*

The transition between the ordinary Simla slates and the magnetiferous slate is gradual. Characteristic is the presence of a blue slate containing beautiful cubes of pyrite just on both sides of the iron-ore bed which is about 400 ft. in thickness.

The ore with the greatest concentration of iron is found in the Chichot Sub-division of the State. Inferior types of magnetite-chlorite-schist have been traced in the northern parts of the State near Barot, Panjaund, Dhamrerh, etc. The better type of ore has been followed for about 12 miles between Pansar and Sangalwara, Chichot. The general strike near Maroti and Sangalwara is N.N.E.—S.S.W. but near Charan it is almost nearing E.-W. It seems that in this latter quarter the strike direction has been affected by the intrusion of the Mandi granite-gneiss massif which is therefore younger than the Krol beds.

Magnetite separated by washing from the disintegrated ore and analysed by Messrs. Pettinson of Newcastle-on-Tyne, showed 73·28% of metallic iron with very little phosphorus and sulphur and a sample of Maroti ore analysed in the laboratories of the Presidency College, Calcutta, gave about 61% of iron. This iron deposit of Chichot was not reported previously.

6. On the determination of the species of Plagioclose by the theodolite microscope.

S. K. Chatterjee, Calcutta.

The author emphasises the importance of the theodolite microscope as affording the only thoroughly reliable means of identifying the species of plagioclase on all occasions, and points out that some help in setting at rest the occasional anomaly observed during the determination of the twin axis can be obtained through the value of the optic axial angle which can be ascertained in the normal course of the investigation with or without slight elaboration.

7. Mode of occurrence and chemical composition of Garnet from Nellore district, Madras.

V. S. Swaminathan, Madras.

Garnet is a common constituent mineral of both the schistose and the pegmatitic rocks, and often occurs as an accessory of the granitic and gneissic outcrops exposed in the country.

Crystalline as well as massive forms are met with, the latter being generally heavy, granular and of a comparatively big size. Dodecahedra, trapezohedra and combinations of these two are the most common crystalline forms.

The dominant colours are red, dark red and varying shades of brown. The specific gravity varies from 3·52–4·15.

A table is given showing the chemical composition of specimens from the area, and the analysis of one sample from Mysore is also included.

Detailed descriptions of the localities and microsections are given, and their economic importance indicated.

8. On a deposit of Barytes in Orchha State. Central India.

M. K. Roy, Calcutta.

In the Orchha State in Central India, in the village Surajpur, formerly called Khura (Lat. 24°43′ 14″, Long. 79°10′ 10″) occurs a deposit of barytes in Bundelkhand gneiss. The vein is traceable for more than a quarter of a mile in length and is over eight feet in thickness. The direction of the vein is approximately N.E.—S.W. It is a quartz-barytes vein in which barytes appears to have been deposited later, filling up the cavities of the quartz vein, and in places, also of the adjoining country rock. A little copper pyrites and malachite are found in the vein but no lead ore. The deposit is of hydatogenetic origin and apparently belongs to a series of several pyritic ore-bodies occurring in the neighbourhood and all having the same N.E.—S.W. direction.

9. The chromite-bearing ultrabasic deposits of Singhbhum district.

C. Mahadevan, Calcutta.

The chromite deposits of Singhbhum, situated 15 miles west and W.S.W. of Chaibasa, the district headquarters, occur in association with pyroxenites, dunites and allied ultrabasic rocks which are now almost completely altered into serpentine and talc. Three main hills and a few occurrences at a lower level constitute the whole intrusion. Of the three main massifs (i.e.) the Roro, the Kitta and the Kimsi, the first is the most productive and the last the most massive.

The relation between the various members of the quartzose family in the area and their influence on ore formation and segregation are discussed in the paper. A general description of the petrographic examination (microscopic), results of analyses of the chromite-ore and a geological map of the area are appended.

From a statistical study of the economics of chromite production for the last four quinquenniums, it is shown that the mining of the ore in Singhbhum has gone on independently of external market conditions of supply and demand, thus demonstrating the complete local consumption of the production. Possibilities of improvement in methods of mining and exploitation are briefly indicated.

10. Origin of the Mica-Pegmatites of Kodarma (Hazaribagh).

S. L. Biswas, Calcutta.

The country rock of Kodarma constitutes the mesozone of the metamorphic belts and consists of mica-schist with subordinate amounts of sillimanite, andalusite, etc. The proportion of the latter minerals increases with the depth as the katazone is approached. The author suggests that the residual plutonic magma which formed the pegmatites and was rich in volatile magmatic substances and rare earth compounds was initially at such a high temperature and under such a pressure as to be able to assimilate rocks of the deeper region whereby it became specially rich in compounds producing muscovite, felspars, etc. Injections through rocks other than mica-schist with sillimanite, andalusite etc., do not appear to have such enrichment in the Kodarma mica area. This accounts for the occurrence of marketable mica in pegmatite veins within mica-schist and not in those cutting through other rocks. When the melt was forced up to its present position in the upper region its thermal activity was so exhausted that no pyrometamorphism was effected. The magmatic emanations, however, produced marked pneumatolytic effect by the formation of minerals like tourmaline in the country rock.

11. The Hornblende Lamprophyres and associated rocks of Mokpalin quarries, Thaton district, Lower Burma.

H. L. CHIBBER, Rangoon.

The writer first visited the area in September, 1926, and a brief notice dealing with these rocks has already been published. The investigation was continued in the laboratory as also in the field, and geological sketch maps of these quarries showing the relations of different rocks were prepared.

There is no reference to the lamprophyric rocks of these quarries, except a short note by Dr. Coggin Brown and no other example of lamprophyre has been described from Burma before.

The P.W.D. quarries, known as the Mokpalin stone quarries, are situated about 3 miles east the Mokpalin Railway station on the Pegu—Moulmein Railway line. There are three quarries known as Nos. 1, 2 and 3 and the rocks of the quarry 3 are different from those of 1 and 2. The petrography of the rocks is as follows:—

(*e*) Contact rocks, e.g., veins of Epidote-rock containing a little quartz and feldspar.
(*d*) Quartz veins, occurring as irregular veins or lenses.
(*c*) Acidic pegmatites and aplite veins.
(*b*) Lamprophyres. The common rock is a hornblende lamprophyre (camptonite) merging sometimes into a dark quartz-diorite-gneiss.
(*a*) Hornblende-biotite-gneiss, quartz-diorite-gneiss and biotite-granite.

12. The volcanic rocks of the Irrawaddy delta, Manngmya District, Lower Burma.

H. L. CHIBBER *and* M. M. WADHWANA, Rangoon.

The present communication forms the seventh instalment of a series of papers on the volcanic and allied rocks of Burma.

The area is represented on the one-inch map-sheet No. 127. Nothing has hitherto been published about the several kinds of volcanic tuffs and ashes excepting the mere description of *Chauk-talon* (*Kyauktalon*—boulder of trachyte) by Theobold. The area which has been geologically mapped is situated on both sides of the Bassein river. On the east of the river the volcanic rocks form a plateau with an average height of about 100 feet presenting a steep scarp towards the river.

The geology of the area has been described as follows:—

(5) Alluvium.
(4) White and greenish fine tuffs.—These tuffs enclose purplish or greyish nodules and boulders of trachytic lava (olivine-trachyte). It has been suggested that the eruptions were of a very explosive nature.
(3) Coarse grained greyish tuffs with *Nummulites.*
(2) Greyish volcanic tuffs and ashes.—These rocks were seen exclusively developed in the hills situated east of the village of Zyat Chaung.
(1) Nummulitic limestones, sandstones and shales. The limestones are remarkable for containing a number of *foraminifera.*

The area represents the southernmost occurrence of volcanic rocks in Burma situated on the igneous line connected with the Arakan Yomas and their continuation to the north and the south where numerous patches of serpentine occur.

13. On some rocks of the Rajmahal Hills.

P. C. DATTA, Calcutta.

A study of rocks collected from a group of small conical hills called Gandesuri in the Rajmahal Hills. These rocks were first described by Ball as 'trachyte' and subsequently as 'andesite' by Col. McMahon. From a physical and chemical study of the specimens the author of the present note has arrived at the conclusion that the rock is a 'basalt.'

14. Notes on rocks from Sihor hills, Bhavnagar, Kathiawar.

V. S. SWAMINATHAN, Madras.

The paper is based on the examination of hand specimens (numbering 30) collected from the Sulidhar, Lamdhar and Tharsingra hills situated west of Sihor town, and placed at the disposal of the author.

Barring a few dyke rocks, rocks of a more or less acidic composition (differentiation products from a basaltic magma) seem to be prevalent in the area.

Macroscopic and microscopic descriptions of the more interesting types, i.e , rhyolites, pitchstones, etc. are given.

The chemical composition of six of the most common rocks is appended, as also a map of the localities from which the specimens were collected.

The Sihor specimens are compared with those found at Girnar and Osham hills in Kathiawar on the one hand, and those at Pawgarh on the other and their general petrogenesis is discussed.

15. Magma-types in the Deccan Trap.

K. K. MATHUR *and* V. S. DUBEY, Benares.

The authors have studied a number of occurrences of igneous rocks, usually regarded as part of the Deccan Trap, in Gujrat, Kathiawar and Cutch. These can be classified into three groups,—

(1) The Mafelsic or Basalt Magma-type.
(2) The Mafic or Ultra-basic Magma-type.
(3) The Felsic or Acid Magma-type.

The first group is represented by the common Deccan Trap of the typical plateau-basalt facies ranging in the later stages of eruption to an alkali-rich basalt. This was followed by intrusions of highly basic rocks. The acid type appeared much later and is represented by rhyolites, granophyres, etc., in various parts of Western India.

These groups appear not to have any immediate genetic relationship through a process of magmatic differentiation, but have probably their source deep down in distinct zones in the earth's crust. They have been traced in South India, the Himalayas, Burma and Western Asia.

About forty exact chemical analyses of Indian rocks have been given in support of the views put forward.

Detailed maps and sections of the Pavagad Hill and the Girnar Hills investigated by the authors have also been given in support of their conclusions.

16. A short note of the sedimentary petrography of some sand-stones of the Raniganj stage from the Raniganj coalfield.

A. K. BANERJEE, Calcutta.

This paper embodies the results of the study of the heavy minerals in the sand-stones associated with the coal seams of the Raniganj stage. Four specimens of sand-stone were examined microscopically and macros-

copically. The result of the microscopic study shows the presence of quartz, felspars, garnet, calcite, biotite and ilmenite. Portions of the hand specimens were crushed and separated by bromoform and the minerals with a specific gravity greater than 2·8 in the order of their frequency, were garnet, zircon, rutile, biotite, tourmaline, monazite, apatite, and an undetermined bluish mineral. The four specimens of sand-stones examined were obtained from the upper, middle and lower divisions of the Raniganj stage, and the author is of opinion that the heavy minerals do not furnish any data for distinguishing the beds from one another. The author has come to the conclusion that the beds of the Raniganj stage were derived from the degradation products of a gneissic area with a granite intrusion and that there was no change in the direction of drainage during the Raniganj stage.

17. On the siliceous oolites from the Cuddapah formation.

L. Rama Rao, Bangalore.

The author undertook sometime ago a microscopic study of the siliceous oolites associated with the rocks of the Cuddapah formation—especially with the object of finding out if any definitely recognisable organic remains could be detected as forming the nuclei of these oolitic grains. Several interesting micro-structural peculiarities shown by these oolites are described and illustrated by means of micro photographs. Special attention is drawn to one or two types of structures which are very persistent, and the question is raised whether they may not be due to some very primitive organism.

18. On the rocks in the neighbourhood of the Chor peak Simla Hills.

N. Chatterjea, Calcutta.

The present paper embodies the results of the physical and chemical study of the infra-Blaini rocks as metamorphosed by the intrusive granite of the Chor peak.

19. Coking Coal. Its nature and synthesis.

Balaram Sen, Jamshedpur.

The author of this paper is of opinion that the coking value of coal does not depend on its ash, volatile matter or fixed carbon, but is due to a resinous substance in the coal (called 'resinoid' by the author), which can be extracted with a suitable solvent. The author has also found out that coal treated with a suitable solvent loses its coking power to an extent depending on the degree of extraction. It has been found that poor coking coals can be made to cake by the judicious addition of pitch or other suitable bond. Increase of volatile matter in the coking coal results in the lowering down of its coking value.

20. The building-stones and road-metal used in Burma.

H. L. Chibber, Rangoon.

The investigation comprises the study of building-stones and road-metals used in each P.W.D. division. The suitability of the rocks (as building-stone and road-metals) of each geological formation found in Burma is also discussed. Special attention has been made to the following points:—

(1) History and the description of the important quarries in each division, including other sources of stone.

(2) Methods of quarrying, labour employed and their wages, cost of transport, etc. and the total cost of stone per 100 cubic feet.
(3) Name and description of rocks obtained from each quarry, with their local names, if any.
(4) The suitability of rocks as a building-stone or road-metal.
(5) Annual output of stone from important quarries of each division.
(6) Annual consumption of stone in each P.W.D. Division.
(7) Works where the stone is employed.

Geological maps, plans and photographs of important quarries accompany the paper.

The materials for the investigation were collected by the author and also kindly supplied to him by the Executive Engineers of the P.W.D. Division, Burma, to whom the author is grateful.

21. Water prospecting in the Deccan Trap country (Bansda State, Surat District).

S. K. Roy, Mandi.

This part of India, although visited regularly by a fairly heavy monsoon, is characterised by a very hot, dry, almost desert climate from March to June. Men as well as animals suffer a good deal and nothing can be grown in the "Regur" soil during this time for want of water.

The author, therefore, while working as the geologist of the State, made a special study of the subterranean water reservoirs of the Deccan Trap country. He made a statistical study of the wells and classified them into cleavage wells, fault wells, intratrappean wells, valley wells, etc. He is of opinion that, if started with some geological knowledge, abundant water can be obtained from a well in the Deccan Trap.

22. Changes in the configuration of sea and land in India and Burma.

M. Vinayak Rao, Calcutta.

During Gondwana times India was considered to have been joined to South Africa by land which disappeared under the sea about the time of the outpouring of the Deccan Trap.

Upper Jurassic beds with marine fossils have been found in Cutch and the east coast of India.

Cretaceous beds have been found at Bagh on the west coast and in the Trichinopoly district at a distance of 40–50 miles from the sea coast. There is evidence to show that there has been an elevation of land during recent times in Tinnevally district in the extreme south of India. Similar elevations have occured along the east coast and also on the coast of Burma. The Andamans have been elevated during Tertiary times.

Though there are local trespasses of the sea such as at Tranquebar there has been a gradual elevation of land during Tertiary times.

23. Tectonics of the Gondwana rocks of the Raniganj Coal field.

S. Sethu Rama Rau, Calcutta.

The Gondwana period commenced with the deposition of boulder beds, and conglomerate, being the last remnants of the glacial action of the Carboniferous times. These form the basal beds of the Talchir series, the earliest member of the Gondwana rocks of India. Since then there have been successive subsidence and elevation, and the process of sedimentation went on without much break. During these times, the Barakars, the Ironstone shales, the Raniganj, and the Panchet series

were formed in regular succession. Of these the Barakars and the Raniganj beds include the important workable coal mines of Bengal.

At the close of the Upper Panchets (Mahadeva stage), severe crustal movements followed which caused the tension and compression of strata, producing many faults, synclinal basins and anticlinal domes. The isostatic movements connected with the drifting of the Australian continent were contemporaneous and caused the outburst of volcanic materials from the underground molten magma. The earliest trap flow of the Rajmahal hills, and the intrusion of ultrabasic rocks in the form of mica-peridotite dykes, along the fissures and fractures caused by faults in the Gondwana rocks, are the emblems of the volcanic outburst mentioned above.

These changes took place during the early Jurassic time.

24. Dicotyledonous plant-remains from the tertiary beds of Assam.

B. SAHNI, Lucknow.

The paper deals with two small collections, (1) from the Tipam Sandstones in Cachar (horizon: Tipam) and (2) from the Tertiary Coal Measures in the Naga Hills.

Collection (1) includes, among other unrecognizable plant-remains, one valve of a fruit of one of the Juglandaceae.

Collection (2) comprises several types of leaf-impressions, among which *Phyllites kamarupensis* Seward (*Rec. G.S.I.*, Vol. 42, p. 94, pl. 17, figs. 1–3, pl. 18 fig. 4, 1912) and at least two other species are represented.

The specimens were kindly lent by the Director, Geological Survey of India.

25. On a new species of *Hemiaster* from the Upper Cretaceous rocks of Southern India.

S. LAKSHMANA RAO, Bangalore.

The paper gives a full description (accompanied by plates) of a new type of *Hemiaster*, from the Upper Cretaceous beds of South India. From the description it will be seen that in several important respects, such as those relating to the outline of the posterior inter-radium, the nature of the peripetalous fasciole, the character of the ornamentation etc., this form differs from all the species of the genus described hitherto from the South Indian Cretaceous rocks and must therefore be considered as representing a new species of *Hemiaster* from the South Indian Cretaceous beds.

26. On the distribution of some fossil Indian Unionidae.

. B. PRASHAD, Calcutta.

The fossil Indian Unionidae are very imperfectly known, and no attempt has hitherto been made to determine the relationships of the fossil and the recent species. The palaeontologists have recorded the Indian fossils as species of the Genus *Unio*, but this genus is not represented by any recent species except in the extreme northwest of the Indian Empire.

The author has been collecting materials for a monographic revision of the Indian fossil Unionidae, and has already published a number of preliminary papers on some of the species. The recent discoveries of the new species of the genera *Parreyssia* Conrad and *Indonaia* Prashad in the Siwalik beds in the Punjab, and the occurrence of a form of *Lamellidens marginalis* Lam. in the Karewas of Kashmir as also in the Siwaliks are of special interest. No recent members of these genera are known from the areas where the fossils were found, and in view of the distribution of the Unionidae being dependent on the river-systems it is clear that the Indian

river-systems in the Siwalik times and earlier were very different from what they are to-day. Additional support for his hypothesis is available from the distribution of the fossil Viviparidae of India.

27. Notes on an undescribed specimen of—*Cyllene*, Gray from the Pegu beds of Burma.

B. B. Gupta, Calcutta.

A new species of *Cyllene* (C. *Vredenburgi*) is described by the author. Comparisons have been made with two species (C. *practicosa* and C. *sp. indet*) from the Pegu beds of Burma and one species (C. *varians*) obtained from the Pliocene beds of Karikal.

28. The lower canine of an Indian species of *Conohyus*.

Guy E. Pilgrim *and* N. K. N. Iyengar, Calcutta.

The paper describes an almost complete mandible of a species of pig which the second author collected from the Kamlial stage of the Lower Siwaliks, ½ mile N.E. of Sadrial village near Khaur, Attock district, Punjab.

The large size and simple conical form of the two last premolars indicate that it belongs to the genus *Conohyus* Pilgrim. It is compared as far as possible with the three known Indian species of *Conohyus*, namely *C. sindiensis*, *C. chinjiensis* and *C. indicus*, as well as with the European, *C. simorrensis*, and seems to agree most nearly with the first of these, to which it is provisionally referred.

The preservation of the lower canine in the specimen is of the greatest interest, since it has been up till now unknown in any of the Indian species of *Conohyus*. It proves to be strongly "scrofic" in outline, thus being in complete agreement with the European *C. simorrensis* and quite different from the contemporary Indian fossil pigs, which are more inclined to the "verrucose" type, in the authors' opinion the more primitive of the two types of lower canine. They consider, therefore, that *Conohyus* represents a precocious development of a "scrofic" canine, which in most other phyla of pigs did not evolve until much later.

The discovery has an important bearing on the origin of the purely Indian genus *Tetraconodon*, which is clearly allied to *Conohyus* by the enlargement of its two last lower premolars. A mandibular ramus of *Tetraconodon*, recently described by the first author, showed that this genus possessed much less "scrofic" canines than those of the new mandible. It follows therefore, if the authors' view as to the derivation of the "scrofic" from the "verrucose" type be correct, that *Tetraconodon* is not derived from any known species of *Conohyus*, but from an earlier one with more "verrucose" canines, and was possibly a later migrant from a developmental centre, in another part of the world, the location of which remains as yet undiscovered.

29. Description of a skull of a bovoid ruminant found in the Upper Siwaliks of Khanpur.

B. K. Bose, Jammu.

The paper records the description of the skull of a bovoid ruminant found in the upper Siwaliks of Khanpur. The skull appears to belong to one of the early types of oxen which have been described by Falconer and others under the generic names of *Probubalus*, *Amphibos*, *Hemibos* and *Peribos*.

Dr. Pilgrim says that primitive oxen existed in the Dhok Pathan stage of the middle Siwaliks. The present skull comes from the upper Siwalik and it is possible that it belongs to the Tatrot stage of the upper

Siwalik. Other fossils have been collected from upper Siwaliks of Khanpur. Among these in addition to *Stegodon*, *Elephas planifrons* is undoubtedly present. This indicates the Pinjore stage of the upper Siwalik. The bovoid skull comes from the beds situated below the Pinjore stage.

30. Geology of the Mandasa estate, Ganjam district, Madras Presidency.

C. K. KRISHNASWAMY *and* V. S. SWAMINATHAN, Madras.

The results of geological traverse across this small and interesting estate form the subject matter of this paper.

The geology of the area is practically an epitome of that of the district, the estate stretching from the Mahendragiri mountain (4919 ft. above the sea level) to the sea coast, and embracing all the ancient and recent formations.

The rocks met with, in their order of abundance, are *a.* gneisses, *b.* khondalites, *c.* charnockites, *d.* granites (containing porphyritic felspar), with associated pegmatite veins, *e.* quartzites, *f* lateritic deposits and *g.* alluvium and beach-sands containing locally concentrations of magnetite and ilmenite.

So far as could be made out, the following table gives the stratigraphical sequence of the formations :—

(vi) Alluvial and beach-sands.
(v) Lateritic deposits with local concentrations of hematite and limonite.
(iv) Granite rocks with associated pegmatites.
(iii) Charnockites (mostly acidic varieties).
(ii) Quartz-garnet-sillimanite schists or khondalites.
(i) Gneissose rocks.

Descriptions of important micro-sections, analyses of a few fresh rocks, and a short note on the economic geology of the estate are also given.

31. The sequence of the geological formations of the island of Bombay.

J. RIBEIRO, Bombay.

In this paper the author has made an attempt to fix the sequence of the various geological formations of the island of Bombay and is of opinion that the various formations of the island of Bombay may be chronologically arranged as given below :—

(8) The littoral concrete.
(7) The white trap of Dharavi.
(6) The three flows of basaltic trap.
(5) The other breccias.
(4) The two flows of scoriaceous trap including the Nowroji hill trap.
(3) The Galanji hill breccias.
(2) The sedimentary beds.
(1) The jasperised rock of Antop hill.

32. Notes on the Tertiaries of the Mandi State.

S. K. ROY, Mandi.

Along a line drawn N.N.E. and S.S.W. almost bisecting the Mandi State, is the inner boundary of the Tertiaries of this part of the Himalayas. This line is also coincident with one of the faults of the "Main Boundary Fault" in which we have now the valleys of the Beas, Suketi, etc.

In one of the lowermost beds of the Tertiaries occurs Mandi salt. Its age is still uncertain. Fossils have not yet been discovered in it. The salt is discordantly overlayed by a "*Decke*" consisting of older metamorphosed Blaini, Krol and Trap beds. It contains angular pebbles of Blaini and Krol dolomite and trap but the author nowhere found fragments of Mandi granite—gneiss in it. The inference is that either the granites are younger than the salt beds or that the granites were not exposed to denudation when the salt beds were being laid down.

The following members of the Tertiaries are represented : Laki (coal and calcarious shale), Subathu (=Kirthar Nummulitic limestone, Ostrea bed and calcareous shale), Dagshai (red clay and fine sandstone with fucoid marks and plant fossils), Kasauli (fine grained, calcareous, brown sandstone and clay), Lower Siwalik (coarse grained, blue sandstone and red clay with *Sabal major* and other plant fossils), middle Siwalik (massive sandstone and greenish nodular clay); and upper Siwalik (various types of conglomerate).

The Nummulitic bed is of great interest as being one of the proofs supporting Dr. Pascoe's prediction of the non-existence of the so long believed interruption of the Nummulitic bed between the Jammu Hills and Simla and also because oil-forming conditions in the Punjab are restricted to one small stage of these Nummulitics.

33. Sedimentation and environmental conditions affecting the life and growth of organisms across subaqueous geological structures during and between orogenic folding periods with special reference to the Tertiary structures of the Irrawaddy valley of Burma.

A. W. G. Bleeck, Yenangyoung.

The author is of opinion that there is a general agreement as regards the reason for and the existence of subaqueous structures of tectonic origin within the Tertiary Pegu Gulf area. The tectonic conditions involve a change from time to time of environmental conditions of sedimentations, the change being from bathyal to neritic and from neritic to deltaic state. The bathyal, neritic and deltaic sediments vary so far as their mineral composition and texture are concerned. Geological field work on the structure of the Irrawaddy valley has proven very considerable thickness of neritic and deltaic sediments and to account for the thicknesses, running into thousands of feet of such deposits, it is necessary to postulate a periodical development, i.e., subsidence of the whole geosynclinal area. The special features of sedimentation across subaqueous structures have been discussed and it has been pointed out that with the changes in the conditions of environment and sedimentation across subaqueous structures, there must have been equivalent changes of the optimum conditions for the existence and development of organisms. The author thinks that a practical application of these views may possibly lead to valuable and significant conclusions regarding oil accumulation and migration.

34. Notes on the Lower Gondwana succession in India.

C. S. Fox, Calcutta.

In this paper the author has described the marine beds of Umaria and given his reasons for holding that they are distinctly unconformable to the underlying Talchir Boulder beds and should be included, at least provisionally, within the Barakar stage. The general features of the Talchir series are dealt with and it has been suggested that the Karharbari stage should be separated from the Talchir series and placed at the very bottom of the Damuda series, the Barakar stage coming over it.

The homotaxis of the Lower Gondwana beds and the nature of the Umaria marine fauna are discussed. According to the author, it is more likely that the Umaria fauna migrated up a channel which lay eastwards along the edges of the base of the Vindhyan scarps of the Son Valley and was connected with the sea through what is now eastern Nepal.

35. Two new occurrences of crystalline limestone from Madura and Tinnevelly districts.

C. K. KRISHNASWAMY *and* V. S. SWAMINATHAN, Madras.

The occurrences are described and the megascopic and the microscopic characters of the rocks are given. Regarding the genesis of the crystalline limestones, the authors are of opinion that the rocks were originally sedimentary in origin and have been subsequently subjected to metamorphism.

Section of Medical and Veterinary Research.

This Section did not meet during the Fifteenth Congress on account of the Seventh Congress of the Far Eastern Association of Tropical Medicine having met shortly before in Calcutta, from 5-10 December, 1927.

Section of Anthropology.

President:—DR. B. S. GUHA, M.A., PH.D.

Presidential Address.

SOME ANTHROPOLOGICAL PROBLEMS IN INDIA.

LADIES AND GENTLEMEN,

Writing in the year 1908 Dr. John Beddoe, one of the most eminent English anthropologists of his generation, spoke of "the enormous and almost incalculable mass of anthropological materials that India offered to the student."[1] During the decade that has followed Dr. Beddoe's writing a considerable mass of valuable information has been gathered both by government initiative and private enterprise, but the work done has been chiefly of the 'survey' kind. Such a survey is essential as a preliminary step for furnishing the first general outline of the entire field of operation but its value depends not so much for the picture it offers, which by reason of its covering a large ground is apt to be superficial, but for enabling us to know the gaps in our knowledge and directing our attention to the spots where deeper and more exact enquiries are likely to be most successful. And no properly planned anthropological research can be said to be complete until this work of reconnaissance is followed up by intensive investigations. The great work of the Sarasin brothers on the Veddas may be cited as an example of what a study of this kind ought to be. In India proper a survey of the physical characters of the population has been undertaken by Risley, Thurston, Waddel; and in a few instances more exact and definite enquiries have also been made, such as those of Ujfalvy, Stein and von Eickstedt in North-western, and Lapicque and Schmidt in Southern India. Due, however, to the lack of specially trained men and a want of proper appreciation of the value of such work, intensive studies have not yet taken place in India in any systematic manner, with the result that our knowledge of the somatic characters of her people is seriously defective. Fortunately, at present there are signs of a better understanding of the importance of such studies and a more fully equipped agency for the work is also available in this country. In order, therefore, investigations conducted in future should bear the utmost results, it is first

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[1] Preface to L. K. A. Iyer's "The Cochin Tribes and Castes," Vol. I, page iv, 1909. Madras.

of all necessary to know the main desiderata in the existing data and understand the problems that have been brought to the front for solution. Consequently, it will be my endeavour in the present address to set forth the chief gaps in our knowledge and bring to your notice the points which hold the keys, as it were, to the entire situation.

The materials at our disposal regarding the physical characters of the people of India concern almost exclusively the living population. Of the races that lived during the long prehistoric period, revealed by extensive finds of artifacts throughout the country, we know practically nothing. In taking stock of our knowledge it will be necessary at the start to confine ourselves to the former and then determine how far its final solution depends on a proper unfolding of the racial history of the past.

The outstanding problems concerning the former are:

(1) The correct affiliation of the aboriginal population of India. There seems to be a general agreement regarding the dominant type among these people which is characterised by a long head, flat broad nose, short stature, wavy to curly hair and very dark complexion. The eye is open and round and the face orthognathic. The researches of the Sarasin brothers in Ceylon, of Rudolf Martin in Malay Peninsula, and of Dr. Fritz Sarasin in Celebes, have shown that it is racially akin to the Veddas, the Sakais and the Toalas of the above regions and together with the Australians form a very primitive and extensive racial family which at one time occupied a great part of the southern World. Judging from its areas of occupation, which is either marginal or inhospitable hills and forests, to which it must have been driven by invading races—there is no doubt that the race is very early in India. We have, however, no positive archæological evidence of its earliest occupation—the only early site which has definitely disclosed this type does not go beyond the stage of iron in Southern India. The point that has to be considered, is, as to whether these people really form a homogeneous race in spite of linguistic and cultural differences or that there are more than one racial type concealed among them? The presence of a Negrito element has been suspected by several anthropologists, on the ground of 'woolly' or 'frizzly' hair having beeen observed among some of the wilder of these tribes. Thus Mr. L. K. A. Iyer[1] writes of noticing 'woolly' hair among the Kadars of Cochin Hills. On the other hand the occurrence of 'woolly' hair is denied by Thurston. The single individual with woolly hair seen by him, in his long experience in Southern India, is of "mixed Tamil and African parentage."

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[1] L. K. A. Iyer—'A Short Note on the Physical Anthropology of the Kadars.' *Man in India*, pp. 29-35, 1923.

Risley is equally emphatic in his denial. To quote his words, "although the terms 'woolly' and 'frizzly' have been loosely applied to the wavy hair, not uncommon among the Dravidians, no good observer has as yet found among any of the Indian races a head of hair that could be correctly described as woolly."[1] Our evidence, therefore, as to the character of hair among the aboriginal population of India is rather conflicting. While the general type is certainly wavy or curly, instances of woolly or frizzly hair may actually occur among some of these people or as is more probable, their reported presence may really be due to superficial observation and the failure to distinguish between extremely curly and genuine woolly or frizzly hair. The question however cannot be decided, until samples of these hairs are collected and submitted to microscopic examination by competent persons. Regarding the presence of a negritoid element in the Indian Continent, it has been further argued, and with a certain amount of plausibility, that even if the present inhabitants do not show any such trait, its presence in the Andaman Islands, is a strong point in favour of its having been in India at one time. A careful enquiry among the Andamanese tribes, however, does not show any relic of Indian migration, all the evidence strongly pointing to their movement from Further India where in the Semangs we have still living a kindred tribe. To settle the question beyond doubt, excavation of the Kitchen Middens and other ancient sites in India is necessary, to find out if there is any skeletal remain which shows definite Negrito characteristics.

So far as the two main linguistic divisions of these tribes are concerned, namely, the Austric and the Dravidian, all the evidence available, in my opinion, go to support Risley's contention of their fundamental somatic unity. There is no important physical character, in which the Austric speaking tribes of this group, differ from that of the Dravidian speaking ones. Consequently, it would considerably clear up the issue if the somatic and ethnic characters of these people are not mixed up, and both are treated independently. It will in that case not only narrow down our field of enquiry and effect a speedier solution of the entire problem of their cultural origins, but may possibly supply us with important materials regarding their migrations and contact with other races.

2. A more intricate problem is the settlement of the so-called Dravidian question. To put it briefly, are there sufficient materials for us to ascribe a definite physical type to the people that may be supposed to have introduced Dravidian language in this country? At the present time the Dravidian

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[1] The People of India by H. Risley, p. 15.

speaking peoples are concentrated in Southern and Central India, with the exception of the Brahuis who are physically akin to other tribes of Beluchistan. Leaving them aside, therefore, the former present at least three distinct racial elements, namely a dolicho-platyrhine or Veddah-Australoid type, a dolicho-leptorhine or Mediterranean type and a brachy-leptorhine or Alpine type.

The measurements published by Thurston and others comprise 120 Tulu speaking people from South Canara, 550 Malayalam speaking people from Malabar, 571 Tamils from Madras and Tinnevelley, two Canarese groups of 410 and 290 individuals from Mysore and the district ot Bellary and Karnool respectively, 356 Telegus from the same districts, 147 men from the Nilghiri Hills and 385 people belonging to the various Jungle tribes. Analysis of the above data on regional lines shows that the main concentration of brachycephaly is in the north-western part of the Madras Presidency, between latitudes 16 and 12 North and up to longitude 78 E; south of latitude 12 on the western coasts, and the Nilghiri Hills, the people are predominantly dolicho-cephalic; on the east from Madras downwards dolichocephaly is dominant again. In other words, the Deccan proper or the tableland between the two Ghats is characterised by brachycephaly, whereas in the region south of it, including the two coastal strips, dolichocephaly is supreme. In the northern brachycephalic region again there is either a predominance of or a tendency towards leptorhiny. In the dolichocephalic western region leptorhiny is dominant, but in the south-western part the tendency is towards platyrhiny—a characteristic marked in the lower classes throughout the Presidency and is most strongly emphasised among the Jungle tribes. In short, the dominant type in the north-west is brachyleptorhine, in the south-west dolicholeptorhine, whereas in the south-east it tends to be dolichoplatyrhine.

In discussing racial affinities, language is not usually regarded as a safe guide, but in the present case a consideration of the physical data in the light of linguistic affiliations of the different groups considered, yields certain interesting results, as it shows that the languages, which indicate the greatest influence of Sanskrit, are spoken by peoples exhibiting marked differences from those, whose languages reveal much less evidence of such influence. Thus Tamil, which is certainly least influenced by Sanskrit and is the oldest of the Dravidian tongues is spoken by the people in the south-eastern part of the Madras Presidency, from Madras to Cape Comorin and extending in the West as far as the Nilghiris, and who are on the whole, among all the groups of whom we possess metric data, the nearest approach to the dolichoplatyrhine type dominant among the Jungle folks.

When we come to Telegu, which is the second-most important Dravidian language and shows a comparatively larger Sanskritic influence, we find it is spoken by people between Madras and Ganjam up to the latitude 18 North and extending as far as the Bellary and Anantpur districts or longitude 78 on the West, who are much more brachycephalic and leptorhine. A comparison with the Tamil speaking-people shows that the mean cephalic index of 358 Telegus is 77·9 or 2·7 units higher than the mean index of 571 Tamils which is 75·2 only. If, however, a comparison is made with the Canarese, and the Marathi speaking peoples of the same districts whose languages show either marked influence of Sanskrit or is entirely Indo-Aryan, a striking contrast is at once noticeable. The mean Cephalic Index of 290 Canarese is one unit and that of 90 Marathis 3·5 units higher than that of the Telegus. On the otherhand the mean Nasal Index of the latter are 8 points and 1·6 units higher than those of the Canarese and the Marathis respectively. Lastly, Malayalam which of all the Dravidian languages perhaps shows the greatest influence of Sanskrit is spoken by people in South-Western coastal belt of the Peninsula, who are markedly dolicholeptorhine. Similarly within each linguistic division if the Brahmins are compared with other groups, the former are found to be much more leptorhine than others.

Taking the two factors together it shows :—

(i) an increasing association between brachycephaly and leptorhiny, accompanied by a falling tendency in the cephalic index with a rising tendency towards platyrhiny and (ii) a close association of Sanskrit language with leptorhiny.

We have unfortunately no metric data east of Longitude 78, but a consideration of them shows, that the southernmost extension of the brachy-leptorhine type goes as far as latitude 12 or roughly the point where the Ghats merge into the Nilghiri Hills, forming the southern boundary of the Daccan proper. Whether the eastward movement of this type reaches as far as the Ghats we are not certain. North of latitude 16, along the western littoral we find the extension of this type up to Guzrat. Whether there has been a gradual deterioration of this type (as is probable) in this southward movement our materials are not enough to come to a definite conclusion, but, there appears to be no doubt that in its movement from the west to the east there has been a gradual falling off of this type. In the light of the deduction mentioned above we may reasonably infer that this falling off in the brachyleptorhine type has been due to miscegenation with a dolichoplatyrhine element with which it increasingly came in contact. We may take it, therefore, that the brachyleptorhine type is an intrusive racial element from the north-west, moving along the margin

of the Western Ghats up to latitude 12, and has gradually diminished as it progressed southwards where the fundamental type presumably had been dolicho.

This would bring the original somatic characters of the Telegu and Tamil people into one group, the former losing its characteristics gradually towards the west, as it came into contact with the broad-headed invaders, the latter except in isolated classes, preserving its almost native purity today. In the course of his investigations, Thurston[1] observed this difference of headform among the inhabitants of Southern India; for writing in 1909 he remarked "whatever may have been the influence which has brought about the existing subbrachycephalic or mesaticephalic types in Northern areas, this influence has not extended Southward into the Tamil and Malayalam land, where Dravidian man remains dolicho or sub-dolicho." We have seen the light thrown by language on this question, which is corroborated by our regional analysis of the existing materials, which, therefore, may be regarded as the only possible hypothesis on our present knowledge. It cannot, however, be regarded as beyond doubt, until the anthropometry of the Telugu country east of longitude 78 as well as the skeletal materials in the numerous prehistoric sites in the Deccan confirm it. It is fortunate that under the leadership of Mr. Ghulam Yazdani, who is energetically excavating the ancient archæological remains in the Nizam's Dominions, we may soon be able to find some human crania which will supply conclusive evidence on the whole problem.

Similarly though the association of leptorhiny with Sanskrit Language is clearly indicated, the presence of the dolicho leptorhine element in Malabar as the result of this influence, cannot be regarded as altogether certain until the excavation of prehistoric sites of this region reveal human crania which support the above hypothesis. The skulls found by Mr. Rea at Adittanallur, in the Tinnevelly district, however, show a distinct tendency towards platyrhiny, as well as a low cranial vault and prominent supra-orbital regions characteristic of the Veddah-Australoid group. Material help can be furnished here by trained philologists, if they undertake field investigations of the languages of the aboriginal tribes of Southern India, in the same way as has been done in the Red Indian languages of North America, for the researches undertaken by the pupils of Pater Schmidt[2] in the Australian languages just before the war, indicate the possibility of a relationship between the Dravidian, Papuan and Australian languages, though nothing positive

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1 The Tribes and Castes of Madras by E. Thurston, Vol. I, Introduction.

2 Die Gliederung der Australischen Sprachen by P. W. Schmidt Anthropos, p. 251, 1912.

can be said till intensive investigations in India confirm it. If such a relationship is shown to exist by future research, the entire Dravidian problem can be regarded as solved, as a definite correlation will then be established between it and the Veddah-Australoid race. The evidence of physical anthropology as indicated above tend on the whole to support this view, which was first propounded by Risley and supported by Turner. The Mediterranean affinities of the Dravidian culture, disclosed in recent researches, would then be due to culture migrations without connoting anything about the race. Whether such a theory is borne out or not, there is no evidence either somatic or archæological, for the view that has lately become fashionable in India and which seeks to make the Dravidian man responsible for the Indus Civilisation as well as that of Sumer; for both of whom are intimately associated with brachycephalic people as the recently discovered skulls in the Pre-Sargonic sites at Kish [1] and El-abaid and Mohenjo-daro indicate.

3. The third problem deals with the existence of the 'Arya-Dravidian' race. In describing the population of the United Provinces of Agra and Oudh, Risley called them 'Arya-Dravidian' i.e. the result of the admixture of the Aryan and Dravidian speaking races, on the ground that the data published by him, show the preponderance of a type marked by dolichocephaly and increased Nasal Index. In studying the distribution of racial types in north-western part of India, the available metric data indicate that the dominant element in this region is characterised by dolichocephaly and true leptorhiny, which is present throughout Northern Rajputana, the Punjab and Kashmir, also probably including Afganistan, and extending in varying proportion as far north as Yarkand. The skulls found at Sialkot, and the recently excavated sites of Nal and Mohenjo-daro reveal the same characteristics. So the present racial element may be said, to be the continuation of the type dominant from the earliest known times. As disclosed in Risley's measurements, there is a sharp break in the eastward extension of this type, which does not go beyond the boundaries of the Punjab in any appreciable degree. The question, therefore, is, whether this represents the real state of things, or, the break is to be regarded as unreal, considering the known facts of history? Now, the anthropometrical measurements published in Risley's name were actually taken by Mr. Chandi Singh, a clerk in the office of Mr. J. C. Nesfield, then Inspector of Schools who supervised him.[2] In the year 1896, however, Surgeon Captain Drake-Brockman, F.R.C.S., M.D., took a large series of measurements of the various castes in the United

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[1] Excavations at Kish by S. Langdon, vol. I, pp. 115–125, Paris, 1924.

[2] Preface to Tribes and Castes of Bengal—Anthropometric data, vol. I, 1891.

Provinces, under the auspices of the local Government. The detail individual measurements are not available but the averages are published by Sir William Crooke. So far as the stature and cephalic index are concerned, there is not much difference between the two series, but when the nasal index is considered a great difference is at once noticed. The mean nasal index for 420 Rajputs and 455 Brahmins as measured by Dr. Brockman are 63·8 and 59·1 respectively, whereas the average nasal index for 100 Rajputs and 100 Brahmins published by Risley are 77·7 and 74·6 respectively. In attempting to determine the comparative reliability of these conflicting sets of measurements, not only the high medical qualification of Dr. Drake-Brockman and the much larger series examined by him have to be taken into consideration, but also the fact that neither Mr. Nesfield nor his assistant Chandi Singh, can in any way be regarded as having had any training in anthropometry, and it is well known that the correct measurement of the nasal length requires considerable anatomical training. On the otherhand it may also be possible that Dr. Drake-Brockman measured the nasal length from the glabella and not from the nasion as was sometimes done in his days. The only skull of known antiquity found at Bayana near Agra tends to support Dr. Brockman's conclusions rather than those of Risely. It is time, therefore, that the importance of this question is realised, and an intensive investigation is undertaken into the racial composition of this region, as Risley's current theory as shown above is open to serious doubt. Besides, as definitely determining the limit of the eastward extension of the racial type, dominant in the Punjab, such an enquiry will clear up many obscure points in the racial history of entire Northern India.

4. The fourth problem is the distribution of the Brachycephalic Alpine type. A survey of the physical characters of the present population of India shows that along the entire western littoral from Guzarat down to Coorg we find the concentration of the brachycephalic Alpine type. This element is dominant among the Guzrati, Marathi and the people of Coorg. As we have already seen, in the south it does not extend beyond latitude 12, and beyond longitude 78 E in the Deccan, as far as our present knowledge indicates. In Upper India, however, from Benares eastwards up to Behar we find the gradual increase of a broadheaded element whose maximum intensity is seen in the population of Bengal. In Bengal proper this dominance of brachycephaly is associated with leptorhiny specially among the upper classes where the leptorhine element is greater than in any other part of India outside the Punjab, if the data published by Risley are to be trusted. In accounting for this brachycephalic factor in Bengal, Risley supposed the influence of a Mongolian race seen on its outskirts. An examination of the

Mongolian tribes along the boundaries of Bengal shows that they are not homogeneous. The brachyplatyrhine element is predominant in the southeastern part bordering on Burma, whereas in the Brahmaputra valley it strongly inclines towards the dolichoplatyrhine; the brachyleptorhine type being dominant only along the Sikkim and Nepal borders. In Bengal on the otherhand, the main concentration of the brachyleptorhine element is in the central or deltaic region, with gradual decrease towards the north and the east. Besides, the Bengali type is differentiated from the Lepcha and kindred tribes, in whom alone of all the Mongolian tribes a marked presence of leptorhiny is found—by having a more prominent nose. In studying the racial anatomy of the nose it is not enough to rely on the relation of the length and the breadth of the nose; the prominence or otherwise of the entire nasal skeleton has to be taken into account. Risley was therefore right in making the latter as the deciding factor in comparing the nasal characters of the Mongolian and other races. In his measurement of the Bengali people, however, the test by which the prominence of the nasal skeleton could be measured, namely the biorbito-nasal-index was not taken except in the case of a solitary group. In the absence of this test, consequently, his conclusion of the Mongolian origin of the Bengali people was not justified on the basis of his own data. Prof. D. R. Bhandarkar has shown, in his interesting account of the cultural affinities of the Nagar Brahmins of Guzarat with the Kayasthas of Bengal, the identity of a large number of surnames of these two groups.[1] A comparison of the anthropometry of these two, therefore, is instructive. The average stature of the Nagar Brahmins as given by Risley is 1643 mm. against 1636 mm. of the Bengali Kayasthas. The average Cephalic and Nasal Indices of the former are 79. 7 and 73. 1 against 78. 2 and 70. 3 of the latter. The average biorbito-nasal-index of the Nagar Brahmins is 116. 7 but in the case of the Bengali Kayasthas the figure is not available but judging from that of the Chandals of Bengal (one of the lowest classes of the population) which is 114.0, this Index in the case of the Bengali Kayasthas could not be much different. Further, when the data are analysed, it is found that 63% of the Nagar Brahmins are brachy and 53% are leptorhine against 60% brachy and 75% leptorhine in the Bengali Brahmins. It is, therefore, difficult to understand how the one could have 'Scythic' and the other Mongolian origin. Besides as Rai Bahadur Ramaproasd Chanda[2] has pointed out, and who incidentally was the first to show the weaknesses in Risley's theory, that the typical Mongolian characteristics such as the presence of the epicanthic fold, absence of bodily hair are not to be found

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1 *Indian Antiquary*, pp. 7-37, 1911. 2 The Indo-Aryans, p. 1.

among the Bengalis. This must not be taken to mean that Mongolian admixture is denied altogether in Bengal—it is simply meant that it is not sufficient to explain the dominant type in Bengal. The only way to account for it is to link it up with that of the western littoral through central India, of which as we have already noticed there is some probability, judging from the identity of surnames. It is in the central region, therefore, that investigation is necessary to find out how far the continuity of type exists from Bombay to Bengal. The origin of this brachycephalic Alpine type in India was hitherto unexplained. The recent discovery of brachycephalic crania in Sind has lent some probability to the theory of a very early migration of this element in India. But its extension both in the south and in the east will never be fully understood until archaeological excavation of the numerous prehistoric sites yields skeletal materials showing these characteristics. The excavation in this connection of the Copper Age remains in the Chotanagpur districts discovered by Rai Sarat Ch. Roy Bahadur, would be of great significance as it may not improbably throw some light on the origins of the people of Bengal.

From a consideration of the foregoing facts it would appear that the greatest necessity in the field of Indian Anthropology is the excavation of the archæological sites in search of remains of its prehistoric inhabitants; for not only the racial history of ancient India cannot be reconstructed without its aid, but it also holds as already stated the secret of the somatic relationships of the present population of India. In the long history of this country whose true antiquity is now being revealed, the only documents that we possess bearing on the physical constitution of its past inhabitants, are the two skulls from Bayana and Sialkot, the skulls from an Iron age site at Adittanallur and the recent finds in the Indus Valley. Outside of these we have no materials for guidance. In his account of the first two of the above skulls, which constitutes almost our sole literature on the subject, Sir Arthur Keith has remarked "There is no anthropological problem more in need of investigation than that of the prehistoric inhabitants of India. We all wish to see applied to India the methods which have brought to light the ancient races of Europe. Nor is there any reason to doubt that there are hidden away in more recent deposits of river valleys and caves, in prehistoric isolated interments and communal cemeteries, records of the ancient races of India. They have not been seen nor found because they have not been patiently and systematically looked for."[1] It is true as Sir Arthur Keith has noted that no systematic search has been made for the skeletal

[1] *Journal of the Bombay Anthropological Society*, p. 663, 1917, Bombay.

remains of the prehistoric races of India, and considering the vast number of ancient sites in this country and their accessibility the lack of interest in these investigations is certainly deploring, but, what is worse, and inexcusable, is the irresponsible manner in which such materials were treated, when luck put them in the hands of our explorers. A great part of the literature on the pre- and early historic sites in India is tragic reading, for the discovery of numerous human skeletons are recorded, but not a trace of them could now be found anywhere in this country! In his account of the excavation of the Great Temple Mound at Indrapura in the Gorakhpur district which roughly corresponded to the ancient Kingdom of Kosala and assigned to the 4th Century A.D.,[1] Mr. Carlleyle,[2] late of the Archæological Survey, writes "I have called this the Skeleton Mound, because I found five human skeletons in it. One of the skulls found had a very projecting jaw exactly like that of a Negro. This belonged to the skeleton of a male nearly 6 feet in length; but close alongside of it I found the skeleton of a female, 5 feet 6 inches in length, the facial part of the skull of which had a straight even profile. Another skeleton was placed across or upon the doorway of one of the temples. Four of the skeletons had their heads placed towards the north but the fifth was placed the reverse way." In another part of the same temple, the writer observes "A human skeleton lay across the doorway. Two more human skeletons of a male and a female lay nearly side by side, while a fourth skeleton lay just beyond the wall toward the west."

Similarly in his excellent work on the 'Indian Prehistoric and Protohistoric Antiquities,' Bruce Foote records the discovery of a human skeleton lying in a flexed position, in a large stone circle, in Central Mysore near Sāvandurga rock.[3] In describing the cairns numbering over 268, at Jewurgi in the Karnool district, in the Madras Presidency, Meadows Taylor[4] mentions the discovery in one, of numerous human skeletons most of whom 'lay in all confusion' and 'some of whom were headless.' Another of these cairns 'contained two human skeletons' and 'many more skeletons and separate skulls were found in the earth above the cist.' In a Neolithic tomb in South Mirzapore, Cockburn[5] found 'the complete fossilized skeleton of an adult male.'

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[1] Catalogue and handbook of the Archœological Collections in the Indian Museum, by John Anderson, Part II. 1883, Cal. pp. 121-122.

[2] Report of the Tours in the Central Doab and Gorakhpur in 1874-75 and 1875-76, pp. 79-80. 1879 Cal.

[3] P. 180.

[4] *Transactions of the Royal Irish Academy*, pp. 337–40, Vol. XXIV, pt. II.

[5] *Indian Antiquary*, Vol. 1, p. 150, also.

Funerary Monuments of India, by G. S. Ghuryee, *Man in India*, pp. 100–139, Vol. VI, 1926.

Not a trace of the skeletons mentioned above, and many more recorded in the accounts of the excavations of the prehistoric sites of India, not mentioned here, could be found at present. One naturally would like to know what has become of them—the documents which are of priceless value in the reconstruction of our ancient history? It is unfortunate but nevertheless true, that hitherto archæology in India meant only the reading of inscriptions and the preservation of ancient monuments. While both of them are necessary they are not its chief functions. Its proper aim should be the reconstruction of the ancient history of a particular land and people. In Europe as well as in Central America, not to speak of Egypt, and the Near East, the unrecorded history has been unearthed by its aid, but in order to be able to do so the fundamental unity of archæology and anthropology has first to be realised. Neither in Europe, nor in Egypt or America such splendid work would have been possible; if the help and co-operation of anthropologists were not sought after; for the culture or civilisation of a people is a complex matter and its full study involves the researches of different lines of workers. Actually, how much can be achieved by the combined efforts of scientists with pure archæologists is to be seen in Pumpelley's excavation of Anau where the team work of geologists, anthropologists, zoologists and archæologists added so much to our knowledge of the ancient civilisation of south-western Siberia. In the excavation of our archæological sites, this aspect of the question has to be more fully recognised than it has hitherto been in this country, not only for the completenes of the work, but more so, for the proper handling and preservation of such of its finds—specially the bones—which require special treatment in the hands of experts, if they are not to be irreparably damaged. Fortunately the discovery of the Indus Civilisation has aroused keen interest in the importance and urgency of archæological studies. and in Sir John Marshall we have a man of wide learning and experience who can be depended upon to direct such investigations in true and scientific lines. We may, therefore, confidently hope that the neglect and irresponsibility shown in the past which led to the loss and destruction of much of the discovered skeletal remains of India's prehistoric inhabitants, will not be repeated in future but proper care and treatment will be accorded to them when found, for which also more systematic search will be necessary. In that way we will be able gradually to add to our knowledge of the racial characters of the prehistoric inhabitants of India, which alone will enable us to understand their present affiliations.

Section of Anthropology.

Abstracts.

1. "Sun-worship in Bengali Nursery-Rhymes."

SARAT CHANDRA MITRA, Calcutta.

There are many little acts which are performed by the people of Europe in the course of their daily lives, which are nothing but symbolical methods of worshipping the Sun-God, which methods are resorted to by the performers thereof without their knowing of it. The European practices of passing the bottle at table, of turning the crank of the butter-churn, beating eggs and stirring mixtures, from right to left in imitation of the sun's course are nothing but survivals of the universal custom of worshipping the Sun-God.

Sun-worship still survives in the nursery rhymes of many peoples. Mr. Sarat Chandra Mitra has published in this paper translations of three Bengali Nursery-rhymes which are chanted by the little children in Lower Bengal on foggy and cloudy mornings without knowing that they thereby are praying to the Sun-God and imploring him to come out of the sky and shine on the earth below, as they are very much in need of his vivifying influence.

2. Indian Parināmvād and the Darwinian Theory of Evolution.

PANCHANAN MITRA, Calcutta.

The history of Parināmvād or Theory of Evolution in ancient India—Rigvedic glimpses, Upanishadic conceptions (e.g. Chhandogya), Sankhya and Vedanta doctrines—Buddhistic viewpoints—mediaeval and modern philosophical developments, Indian theories—introspective and cosmogonal—admitting no barriers between material, biological and mental, based upon empirical observations of organic life not confined to Biology as in the Darwinian Theory.

3. Head dresses of some of the Hill-tribes of Assam.

PROVASH CHANDRA BASU, Calcutta

(Communicated by Dr. B. S. Guha.)

(A study based on the specimens in the Ethnographic gallery of the Indian Museum.)

1. General description of the head gear with its morphology, technique, texture, decoration, etc.
2. Classification of the material.
3. A study of its distribution.

4. Culture contact in Ancient India.

RAMAPRASAD CHANDA, Calcutta.

Immolation of widowed wife once allowed for non-Brahmans only—later on general. Human sacrifice—symbolical in the Vedic period, but later on practised in connection with Sakti worship.

5. India's contribution to the culture of South-east Asia and Indonesia.

KALIDAS NAG, Calcutta.

A study of the spread of Indian civilisation in South-east Asia and Indonesia as depicted in the art and rituals of these regions.

6. The use of nose ornaments in India.

K. N. CHATTERJEE, Calcutta.

The absence of such ornaments in sculptural or fresco remains of ancient and early mediaeval periods in India. No mention in Sanskrit literature—present day names non-Sanskritic in derivation. Earlier Mogul paintings—absence of nose ornaments. Probable source from where these ornaments were introduced into India. Present distribution, names and descriptions.

7. On a Lushai Kuki aetiological myth about the King-Crow.

SARAT CHANDRA MITRA, Calcutta.

The Lushai Kukis are a mongoloid people living in the hill-tracts to the east of Assam. They believe that the eclipse of the sun takes place by reason of the fact that a ghostly being called the *Awk* devours this great luminary. On one occasion this being so completely devoured the sun that a great darkness overshadowed the world. This incident is called by the Lushai Kukis the "*Thimzing.*" During this terrible time a general transformation took place and men were transformed into beasts and birds. In this time also the Lushai Kuki chiefs who were fond of the long tail-feathers of the King-Crow (*Dicrurus ater*), were metamorphosed into this bird.

This aetiological myth illustrates that cardinal doctrine of the philosophy of the lower culture, according to which the savages believe that beasts and birds can talk like human beings and human beings can readily change themselves into beasts and birds. Accordingly, the primitive Lushai Kukis believe in the interchangeability of man and beasts, for they have invented the myth to the effect that in the course of the darkness following the eclipse, the chiefs were readily metamorphosed into King-Crows.

8. A plea for the protection of Aborigines in India.

ASOKE CHATTERJEE, Calcutta.

Some of the aboriginal tribes in India, e.g. the Andamanese and the Todas are fast dying out. It is necessary that steps are taken for their protection and preservation in the light of those taken in U.S.A., Canada and Australia before it is too late. It is urged that a resolution requesting the Government of India to take the necessary measures be passed by the Science Congress.

9. Primitive religion in Chota-Nagpur.

SARAT CHANDRA ROY, Ranchi.

In this paper the essential difference amid the general similarity of the religious systems of the hill-tribes of Chota-Nagpur is sought to be brought out by an analysis of the religious ideas of some of the more important tribes.

10. Zones of Indian cultural influence in South-east Asia and Oceania.

E. S. CRAIGHILL HANDY, Honolulu.

11. Women's place in the folk art of Bengal.

MRS. SANTA NAG, Calcutta.

An attempt is made to describe and analyse the significance of various Alpana designs drawn by women in some of the popular socio-religious ceremonies of Bengal.

12. Origin and social organisation of certain royal families of South India.

K. P. CHATTOPADHYA, Calcutta.

The data from literature—the data from inscriptions—the data from coins—their ethnological significance—determination of dates of certain rulers on the basis of the ethnological conclusions—their agreement in detail with conclusions drawn from other sources, the proof of the correctness of the views put forward.

13. Some modern painted pottery designs from the neighbouring villages of Mohenjo-daro.

PANCHANAN MITRA, Calcutta.

Some specimens of modern pottery of the neighbouring villages of Mohenjo-daro that I visited—though morphologically distinct—have similar ornamental designs with those of ancient Mohenjo-daro showing the perpetuation of the same technique up to the present day.

14. The primitive races of the Andaman basin.

R. B. SEYMOUR SEWELL, Calcutta.

Physical characters, by means of which we discriminate between different human races, are developed late in life and mainly at the onset of puberty. Recent studies in medicine have shown the importance in the development of the individual of certain chemical substances, either contained in food material or secreted by internal glands. A polyphyletic origin of genera and species in the animal world is now a recognised possibility and the same must equally hold good for man. Similarity of structure may, therefore, be due to similar habits or environment and not be evidence of consanguinity. Anthropologists must study not only mankind but his surroundings on which food supply depends, and even the meteorology of the region occupied. The Andaman Sea basin includes the homes of three primitive races and is, therefore, a favourable locality for the prosecution of such researches.

15. On the cult of the Godling Uttama Thākura in the district of Mymensingh in Eastern Bengal.

SARAT CHANDRA MITRA, Calcutta.

In the district of Mymensingh in Eastern Bengal unmarried girls worship, during the spring, two godlings named Uttama Thākura and Basanta Rāya who appear to have been originally tree-spirits immanent in the Kadam, Neem and Bael trees. These are worshipped by the

girls standing at the foot of any one of the aforementioned trees and by making offerings of various kinds of spring-flowers, blades of Durvā-grass, unhusked paddy and little clods of earth. They chant a prayer-formula while making these offerings. After finishing this puja they sing two other songs of which the texts and English translations have been published in this paper. They worship these godlings for obtaining the boon that they may get married to handsome husbands.

The facts, that the girls perform the *puja* at the foot of the aforementioned trees, that no Brahman priests officiate in this worship, and that the names of the aforementioned godlings are not mentioned in any Hindu work on mythology, lend considerable plausibility to the theory that they were originally tree-spirits.

The practice of offering little clods of earth to these deities appear to have been borrowed from the Buddhists.

16. The woman and the family in the Heroic Age.

N. K. Siddhanta, Lucknow.

Superficially speaking, neither the woman nor family ties seem to have counted for much in the heroic age. The general attitude towards women is something like that of the Servian hero, Marko, as seen in his treatment of the sister of Leka Kapetan, of the daughter of the Moorish King and of the wife of Philip the Mayzar. Equally typical are the Cid's persecution of Dona Ximena (Poema del Cid. VII) and Odysseus' instructions to Telemachos in the Odyssey XXII 438ff. Moreover bonds of kinship seem to have been loosened in the Heroic Age and the heroic poems pre-occupied with deeds of valour have little to do with pictures of domestic life. Yet there are some materials in the domestic episodes and incidental passages throwing light on the status of woman and the strength or weakness of family ties.

Bonds of kinship seem on the point of disintegration in the Heroic Age and there are too many instances of domestic strife. This disintegration was probably due to a transitional stage in kindred organisation, in the strengthening of patrilinear relationship as opposed to the matrilinear. In the period immediately preceding the Heroic Age family ties were perhaps quite strong. In the Heroic Age itself, in India, as in other countries, ties of marriage were frequently utilized for forming and cementing military alliances.

The institution of marriage deserves detailed study. Payment of a bride price was common. Payment of a dowry to a daughter or son-in-law was not unknown. There are many instances of marriage by mutual consent, an important variant of which was the *Svayamvara*. The pure Svayamvara is to be distinguished from the winning of a bride through a deed of prowess as in the marriage of Draupadi or Sita or Penelope. This latter is also explained as the payment of a bride-price with prowess, and is not very different from another common method in the Heroic Age, marriage by forcible capture as with Arjuna and Subhadra or Hethinn and Hildr. The bride had generally to leave her own home and proceed to her husband's; but there are exceptions. Polygamy was quite common and there are instances of polyandry and levirate in the Sanskrit records. Love-marriages were not unknown and if the queen was a forceful woman she could manipulate public affairs to a great extent. The custom of *Suttee* is mentioned in the Indian epics and was known in the West too.

17. The Tigari—a primitive type of boat used in E. Bengal.

B. Prashad, Calcutta.

In 1920 the author published a description of a large earthen pot which is used as a boat in certain parts of Eastern Bengal. The author

gives an account of certain further observations about this primitive but very interesting type of "boat", and compares it with coracles, bulrush-rafts and goat and buffalo-skin rafts which are used in other parts of India as substitutes for boats.

18. Notes on an Indian community mentioned by Pallas.

K. N. CHATTERJEE, Calcutta.

Description of an isolated group of Hindu traders settled in Russian Asiatic territory during the latter part of the eighteenth century.

19. Life and customs of the Lapps.

J. KONIETZKO, Hamburg.

20. A statistical study of the anthropometry of the Bhumihars of the Patna District.

H. C. CHAKLADAR, Calcutta.

Number of subjects measured—85. Measurements taken—Head length, Head breadth, Nasal length, Nasal width, Stature. Indices calculated—Cephalic Index, Nasal Index. Statistical Studies. Conclusion.

21. Some norms of Ho Culture.

D. N. MAJUMDAR, Lucknow.

Ethnographic descriptions of earlier observers like Cols. Tickell and Dalton and Sir Henry Ricketts compared, the change in their outlook accounted for, general characteristics of the people, influence of environment on their primitive culture, influence of the establishment of law courts—instead of doing any good to the tribal population, the law courts have trained them to foster a spirit of litigation. The village council of the Hos, the gradual weakening of its hold on the people, the causes thereof. Personal dress, past and present; village system, does not materially differ from that of other sections of the Mundari speaking people, the origin of Mankidom, the social structure of the Hos, exogamy and endogamy, relation between totemism and exogamy, origin of local exogamy, social life of the people, the origin of village dormitories.

22. Note on a recent instance of human sacrifice for discovering hidden treasures.

SARAT CHANDRA MITRA, Calcutta.

There is current in many countries throughout the world a widespread belief that avaricious and miserly persons who accumulate great hordes of wealth during their life-time, cannot take away their thoughts from their riches even after their deaths. They therefore assume the shape of monstrous snakes and guard their treasures hidden under the earth. When disgusted with their life as snake-guardians of treasure-trove, they ask some covetous person to take possession of the hidden treasures by sacrificing to them some one of their dearest kinsmen. The prevalence of this belief in India has received a striking illustration from a recent case which has cropped up in the Nizam's Dominion. A rich woman named Rādhāma of village Yelamner kidnapped a child and sacrificed it to find out a hidden treasure. This case has been fully described and dealt with in this paper.

23. Some observations on the physical features of the Brahuis.

PANCHANAN MITRA, Calcutta.

The Brahui physical type is not a homogeneous one but comprises at least two groups due possibly to admixture similar to the broad-headed and long-headed, fine-nosed, light-skinned, peoples of the Punjab and Sind and quite dissimilar to the Dravidian physical type of the south though speaking a Dravidian language. A few measurements analysed.

24. Note on a musical instrument found in the Shan States.

H. S. SRINIVASA RAO, Calcutta.

25. The frog in North Indian rain-compelling rites.

SARAT CHANDRA MITRA, Calcutta.

The frog plays an important part in the rain-compelling rites performed by many races all over the world. Sir J. G. Frazer accounts for this by formulating the theory that those peoples believe the frogs to be the custodians of rain. But Mr. Sarat Chandra Mitra says, that this theory is not applicable to the rain-compelling rites performed by the Hindus of Northern India. These Hindus believe *Indra* to be the rain-god and that the frogs are his myrmidons. If the appearance of the frogs during the rains is travestied by throwing jugs of water containing frogs into neighbour's court-yards, the rain-god is pleased and sends down copious rain or if the frog is tortured the rain-god feels pity for his favourite's sufferings and so far relents that he sends down copious rain. But the most curious rite is "*the marriage of frogs*" which is performed in Assam, the root idea lying at the basis of this rite is that the god becomes very much pleased with the performers of this rite because by the marriage of his favourites they will increase and multiply. As a sign of his favour the god causes copious rain to fall.

26. The cult of the dead among the Hos.

D. N. MAJUMDAR, Lucknow.

Ideas about soul and spirits, belief about reincarnation, causes of death, influence of "bongas" on Ho life, beneficent and maleficent spirits, personal and impersonal forces, spirits and gods, epidemics and their remedies, detailed descriptions of their customs and tabus observed at death.

27. On an aetiological myth about the Golden-backed Woodpecker, the Indian Spotted Woodpecker and other species.

SARAT CHANDRA MITRA, Calcutta.

The Golden-backed Woodpecker (*Brachypternus aurantius*), the Indian Spotted Woodpecker (*Picus macii*) and other species of woodpecker derive their names from their habit of tapping the trunks of trees with their bills. There is current in several parts of Bengal a myth which accounts for the origin of this habit and which has been published and fully discussed in this paper. The main incidents of the myth are that a hungry and thirsty ascetic asked an old woman for food and drink of water which she truculently refused to give him. On this the angry ascetic cursed her with a curse that thenceforth she would have to

seek her food in the holes and crevices of the trunks of the trees and to quench her thirst by drinking rain-water only. As soon as this curse was pronounced she was metamorphosed into a Woodpecker. It has been compared with another myth which is current in France and in which it is stated that, at the time of creation of the world, the task of excavating the seas, lakes, and rivers was entrusted to the Woodpecker, but it was refused. Hence a similar curse was pronounced upon it.

28. Stone implements of the Andamanese.

PANCHANAN MITRA, Calcutta.

Six stone implements in the Indian Museum studied and their technique discussed. The theories of Sollas-Brown's observations. The stage of stone culture of the Andamanese in relation to other stone using primitive peoples of Asia.

29. On the cults of the maritime deities in Lower Bengal.

SARAT CHANDRA MITRA, Calcutta.

In Buddhist times, Hindu and Buddhist merchants used to undertake long sea-voyages for trading purposes, became wealthy and attained high social status. For ensuring the safety of themselves and of their personal staff and for obtaining success in their commercial enterprises the Hindu merchants used to worship the rain-god Indra and Manasā, the Goddess of snakes. For the same purpose and for ensuring the safe return home of their merchant-kinsmen their women-folk used to worship two goddesslings—one named Suo Duo or Sodo and the other named Bhāduli. The cult-rites performed in adoration of them have been described and fully discussed in this paper.

One notable feature of these cult-rites is that the celebrants set afloat in tanks, rivers or miniature excavated seas, miniature flower-decked and illuminated boats made of the fleshy spathe of the plantain tree as votive offerings.

Both these cults appear to be of non-Aryan origin. The primitive non-Aryan people of Lower Bengal looked upon the seas and rivers not only as the dwelling place of powerful water-spirits, but also as the spirits themselves whom they named Sodo and Bhāduli, because they had the power of keeping the absent traders in safety.

30. Notes on a rite for propitiating the tiger-deity in the district of Mymensingh in Eastern Bengal.

SARAT CHANDRA MITRA, Calcutta.

In this paper Sarat Chandra Mitra publishes the text and English translation of a Bengali song or hymn which is chanted by the woman-folk of the district of Mymensingh in Eastern Bengal on the night of the day fixed for worshipping Kārtika, the Indian God of War. The worship is held on the last day of the Bengali month of Kārtika (October-November) when the weather begins to be cold. From the evidence of this song, Mr. Sarat Chandra Mitra infers that, in ancient times, Mymensingh was full of forests which were haunted by numerous ferocious tigers which committed terrible havoc on the people and their live-stock. For appeasing the tiger-deity's wrath and for putting a check to his depredations the people began to worship him towards the close of Kārtika. On the occasion of this Puja the afore-mentioned hymns used to be chanted. In course of time the worship fell into desuetude but the singing of the songs has continued to the present day.

31. Note on Dog-worship in the Hazaribagh district in Chota Nagpur.

SARAT CHANDRA MITRA, Calcutta.

Lugu is a goddessling who is much adored and prayed to by the Kolarian peoples including the Mundas, the Santāls, the Kharwars and the Birhors, who inhabit the district of Hazaribagh. She resides on Lugu Hill with her army of *Birs* or warriors of whom the leader is *Tulsi Bir*. During the period from 1900 to 1920 there occurred in the district of Hazaribagh eight cases in which *Tulsi Bir* is said to have taken possession of dogs and thereby caused these beasts to be worshipped by the aboriginal peoples of the district. Vermilion marks were made on the foreheads of these beasts and garlands of flowers or coloured threads were placed round their necks. They were escorted from village to village by drummers and retinues and ultimately led to Lugu Hill where the godling is said to have left them.

Mr. Sarat Chandra Mitra is of the opinion that the afore-mentioned instance of the dog-worship has originated in the animistic belief of the aboriginal peoples of the Hazaribagh District.

32. Further note on a Ho Folk-tale of the Wicked Queen's Type.

SARAT CHANDRA MITRA, Calcutta.

In this paper, Sarat Chandra Mitra describes and discusses the root-idea which lies at the basis of the practice of woman eating fruits and other things for the purpose of procuring children. Examples of this practice from Ho and Santali folk-tales have been described in this paper. Savages look upon conception and birth with awe as being things not understood. They are attributed to causes different from human and often super-human which operate on the woman, who is the agent of birth. The man's relation with conception and birth is disregarded and these are ascribed to all sorts of causes alien from humanity such as fish, plants and even stones. Hence arise the practices adopted by women all over the world for obtaining children, such as eating fruits, roots, seeds and so forth.

33. On a bird-myth from the district of Tippera in Eastern Bengal.

SARAT CHANDRA MITRA, Calcutta.

There is current, in the district of Tippera in Eastern Bengal, a bird-myth, of which the main incidents are as follows :—

When the heroine's younger sister is swinging from a tree on the bank of a streamlet, the heroine gives her such a push that the former falls down into the water below and is swallowed by a huge *Boāl-fish* (*Wallago attu*) lying there. On returning home the heroine gives her parents an unsatisfactory explanation about her younger sister's non-appearance. The next day the mother discovers the younger sister living in the fish's belly and rescues her therefrom. Learning from her about the heroine's wickedness the parents punish the heroine by shutting her up in a pig-sty. Being disgusted with the cruel punishment meted out to her she borrows some feathers from the *Nāoya*-birds and fixing them on to her arms flies away with those birds.

This myth has been compared with a similar one current among the Garos of Assam. But Mr. Mitra thinks that these two have been evolved independently of each other.

34. Some aspects of the problem of life after death as conceived by the Australian tribes.

CHITTARANJAN ROY, Calcutta.

(Communicated by Dr. B. S. Guha.)

A discussion of the question of the existence of life after death as viewed by the aboriginal tribes of Australia—their interrelation and comparison.

35. On an aetiological myth about the Night-Flowering Jasmine.

SARAT CHANDRA MITRA, Calcutta.

In this paper a myth about the evolution of the Night-Flowering Jasmine (*Nyctanthes arbortristis*) has been published and discussed. The daughter of King Parisatice is wooed by the Sun and subsequently deserted by the latter basely. In a fit of despair she committed suicide and was burnt on a funeral pyre. From her ashes sprang the Night-Flowering Jasmine. The root-idea lying at the basis of this myth is the savage belief that souls of dead men and, for the matter of that, the different parts of the bodies of dead persons may grow up into trees, or blossom forth as flowers. This conception is common in folk-lore and in poetry. Based on this belief is the pretty poetical concept of flowers springing up from the graves or ashes of dead lovers.

36. On a second aetiological myth about the Indian black-headed Oriole.

SARAT CHANDRA MITRA, Calcutta.

In this paper, second myth from Eastern Bengal accounting for the origin of the yellow plumage and the black head, wings and tail of the Indian Black-headed Oriole (*Oriolus melanocephalus*), has been published and discussed. The main incidents of this myth are that a mother-in-law having repeatedly tried in vain to cook for her son-in-law a pulse soup of the right yellow colour, in a fit of despondency, broke upon her own head the soot-begrimed earthen pot containing the yellow pulse-soup. The yellow turmeric paste in the soup stained her body yellow and the soot in the earthen pot stained her head and lower limbs black. The benign gods felt the compassion for her pitiable condition and metamorphosed her into the afore-mentioned bird, whereupon she flew away.

This myth has been compared with another variant from the District of Faridpur in Eastern Bengal.

37. On a Lushai Kuki aetiological myth about the Jungle Babbler.

SARAT CHANDRA MITRA, Calcutta.

The Lushai Kukis are a Mongoloid people who live in the rocky fastnesses of the hill tracts to the east of Assam. There is prevalent among them an interesting myth which accounts for the evolution of the Jungle Babbler (*Crateropus canorus* Linn.). These people believe and state that, on one occasion, a ghostly being called by them the *Awk* so completely devoured the sun that a great darkness overshadowed the world. This is called by them the "*Thimzing*." All sorts of wonderful transformations took place during this time. Those men who with white turbans on their heads were going to their hill-side cultivation were transformed into Jungle Babblers. S. C. Mitra is of opinion that this myth strikingly illustrates the cardinal doctrine of the Philosophy of

the Lower Culture, that there is no distinction between man and beast, and that, the savage mind is quite unconscious of the line of difference that exists between these two great divisions of the created beings.

38. Further notes on the Behari myth about the Indian House-Crow.

SARAT CHANDRA MITRA, Calcutta.

In a previous paper, it has been shown that considerable animosity exists between the Indian house-crow (*Corvus splendens*) and the domestic cat. It often takes place that while the cat is feeding upon some food, the house-crow will come and pull at his tail. The primitive myth-maker of Bihar has accounted for this enmity by inventing a myth to the effect that the Indian house-crows were once palki-bearers, that the cat was a Rani who had hired the former's palki but had not paid the hire to the former and that it is for this reason that the former dun the latter for the payment of the overdue hire by pulling at the latter's tail.

Recent enquiries have shown that similar animosity exists between the house-crow on the one hand and the dog and the kite on the other. But Mr. S. C. Mitra is not aware whether there is current in any part of India an aetiological myth similar to the Behari one, which accounts for the enmity between these creatures. He therefore suggests the search for any such myth.

39. Notes on tree-cults in the district of Patna in South Bihar.

SARAT CHANDRA MITRA, Calcutta.

The worship of a small mound of clay standing at the foot of a Pipal tree (*Ficus religiosa*) which was witnessed by Mr. Sarat Chandra Mitra at Patna on the 5th October, 1927, has been described in this paper. The author thinks that the godling Bärhām, who is symbolised by the mound of clay, was originally a tree-spirit dwelling in the Pipal tree standing close by. The ingredients used in the worship of this godling and the *modus operandi* of this worship have also been described. The worship is performed by persons desirous of having their heart's desires fulfilled. The most curious offerings that are used in the worship of this godling are sacred thread (Janao) made of jute fibre and ganja. For reasons stated in detail in the paper Mr. S. C. Mitra is of opinion that this cult is of aboriginal origin.

40. Ants and folk-beliefs in South India.

S. T. MOSES, Calicut.

Ant and industry—Solomon's ant and Muhamadan paradise—granary ants and prevision—Ants' grass-rice and famine—dropping rice grains in antholes an act of merit—migration of ants with 'eggs' and weather-march of ants in files—Snake-ants of Kerala—the ant law (Pipilika Nyayam). Ancient military ant array (Suchi Vyuha)—ants and white lines—Marching ants and ill luck to hunter or owner—Swarming and weather forecast—Swarming usually unlucky—not so in Godavary—Ants and wings—Delicate termite wing—Ants of Herodotus and Maha-Bharata's gold digging ants—Ant's three senses—Eyes proverbially large—Antbites and proverbs—nonbiter ascetic—Biting fire-ants and ghosts—Ants and sugar-cane juice offering at Thiruverumbiyur—Ghee ants in Naladyar—Destructive ants and proverbs—Anthill and Siva, Valmiki—Vedans—Anthill earth and Khond's oath—Anthills and snakes—ants as human food—queen ter-

mite and athletes—ants as tonic—medicinal ant-nest balm—termite-fed scorpion oil medicinal—destruction of ants by trampling, salt, fire or water.

41. Funeral rites of the ancient Tamils.

P. M. SOMASUNDARAN, Bangalore.

An account of the different methods of disposing of the dead, and ceremonies associated with them, gathered from classical Tamil literature. Archaeological and epigraphical evidences. Comparison with Egyptian, and Sumerian customs. Survivals at the present day, of such rites in South India.

42. The Pondans of Calicut.

S. T. MOSES, Calicut.

The Palanquin-bearers of the West coast, traditional and of to-day—The Pondans, their origin, present day occupation, customs, manners, speech and social privileges.

43. Laws of eugenics and the institution of marriage amongst Hindus.

S. S. MEHTA, Bombay.

Eugenics is the science of Race-Culture. It is easy to see that the agriculturist aims at the improvement of his corn; and the eugenist in a similar way aims at the improvement of the human race. The main object of the agriculturist is to produce the best kind of corn and that of the eugenist is to produce the best species of mankind meaning to say men who could be both sound in body and sound in mind. He tries to examine, regulate and reform as well as improve in reforming everything pertaining to man such as his form, his colour, his habits and his performances, i.e., pertaining to man as an individual as well as a species in the kingdom of nature. And although man is the highest and most important of the known living creatures on the earth, yet very little attention is reported to have been paid to this important branch of study, till our eyes were opened to the various ways in which most of the leading principles of eugenics were shown to have been applied in practice by Hindu Legislators. The Vedic times, the Epic age and the rationalistic period all tend to show how the principles of this useful science were observed ceremoniously by the Hindus in ancient times, who have handed down the tradition to the generations of the civilised 20th century, when science in all the branches is making rapid strides, in order to cope with the varying needs and exigencies of the hour.

The whole Hindu Society was then based on the laws of heredity. The legislation, too, proceeded on the line of believing that the seed imparts not only the physical but even the intellectual and moral qualities of parents to their progeny; and that inherited proclivities were perfected by practice, and ingrained in the coming generations. Castes were originally meant to be marriage groups; and as such they were intended to carry on the same profession by marrying among themselves. Thus the threads of different professions were carried on unbroken. For instance, the Brahman would choose, under normal conditions his spouse from the castes to which he belonged; and his children would bring to perfection the same vocation for which he was trained; a man of warlike pursuits would do so in his own caste; and similarly also, a trader too in his own caste. Castes, however, were not a small group; and notwithstanding this, there was a fear of inbreeding proving a source of weak progeny by the law of heredity. To ward off this evil effect, marriages among

"Sapindas," i.e., the issues of the same forefathers were prevented; and among higher classes, marriages among "Sagotris" were prohibited, i.e., among the descendants of the same Rishi; and among still higher class Brahmins, the same were banned as occurring among the descendants of four Gotras, viz., that of the groom's father; of his mother's father; of the father of his mother's mother and of the father of his father's mother.

On the other hand it will be seen from numerous instances that new blood was imported from distant places. Evidence is not wanting to show that Hindu Kings married the daughters of Greek Kings; some of them married the daughters of Patala Loka, i.e., the inhabitants of Peru, Mexico and such other races; and marriages between Indians on the one hand and Nepalese, Tibetans, Kabulis and Persians were of frequent occurrence. Kaikeyi, one of the queens of King Dasharatha, was the daughter of the King of Kabul. Instances could be multiplied from the Ramayana and the Mahabharata as well as from the great writings of Kalidas, the poet of poets.

44. Indian and Roman marriage ceremonies compared.

S. S. Mehta, Bombay.

Since the commencement of civilization, the Hindoos have considered marriage as a unifying act for lifetime, and the restraint of chastity came to be put on the sexual desire of the married couple. According to Spencer, in the primitive stage, in the west, man had no marriage institution and the sexual union was a matter of passing desire free from all permanent obligations. In the epic period of Indian-Aryan civilization, propagation of race was a predominant idea and a woman could be permitted to have children begotten in lieu by the best specimens of the race, as required by the principles of eugenics. Marriage is a sort of limitation imposed upon sexual relations.

According to Prof. W. B. McDaniel, a Roman union was a marriage of convenience, so that, the bride and the bridegroom had to depend upon a post-marital propinquity to develop a love that precedes American marriages. The Roman marriage had three forms: (i) the Confarreate wedding, so called because the couple ate together a cake of Spelt for a sacred offering to Jupiter; (ii) the marriage effected by a fictitious sale of the bride to the bridegroom in the presence of 5 witnesses, and of a person who held a pair of scales; (iii) the marriage that demanded a year of uninterrupted living together. There was no bethrothal among the early Romans. Among the Italians in an American city, betrothal is purely a parental affair, the girl not even knowing whom she was to marry. The maiden wore an iron ring on the third finger of left hand from which it was believed a nerve ran straight to her heart. The Indian Aryans believed the left part of a woman's body holier than the right side and the third finger to be more suited to the growth of love. As regards the age of the couple among the early Romans, a girl could marry at 12 and a boy at 14. A ban is laid on Tuesday and Friday for marriage. A striking similarity exists as regards (1) parental accord; (2) consent of the marrying couple; (3) joining of right hands before witnesses; (4) escorting the bride to her husband's place in procession; (5) the groom dividing the girl's hair into six tresses, whereas among the Hindus the hair is divided into three tresses; (6) the bride wearing a garland of flowers during matrimony; (7) initial marriage ceremonies which are performed at the house of the bride's father; (8) a professional diviner (astrologer) ascertaining the omens; (9) a matron friend of the bride clasping the couple's right hands; (10) the ceremony performed when the evening star rose. The true idea of marriage is the union of souls for uplifting the conditions of the couples towards their mutual spiritual advancement.

45. On the need for standardisation in measurements on the living.

P. C. MAHALANOBIS, Calcutta.

46. The Brahmins of Bengal—a statistical study of the anthropometry of the main Brahmin groups of Bengal.

T. C. RAI CHOWDHURI, Calcutta.

47. A first study of the Chinese head.

P. C. MAHALANOBIS, Calcutta.

48. Exogamy among the Mala-Aryans of Travancore.

L. A. KRISHNA IYER, Calcutta.

The Social organization of the Mala-Aryans is built on the foundations of exogamy. The tribe is divided into 6 clans. Members of the same clan stand in the relation of brother and sister, and it would be incestuous to marry within the same clan. According to Westermarck, exogamous rules are regarded as social survivals from very remote times and the underlying idea is to keep the home free from incestuous intercourse.

49. Anthropometry of the Kanikars of Travancore.

L. A. KRISHNA IYER, Calcutta.

Anthropometry as a test of race stands much discredited in the eyes of many eminent anthropologists. There are at the same time ardent supporters who rely on the absolute certainty of the nasal and cephalic indices, of hair, and colour as permanent tests of racial distinction.

Collignon formulates the theory that, in a given race, leptorhiny is in direct relation to stature. The more it is raised, the longer the nose. The lower the stature, the more the nose tends towards mesorhiny. The nasal index of the jungle Kanikars is found to be higher than that of the domesticated Kanikars of the plains. This change is a result of contact metamorphosis.

50. Symbolic sacrifice of cows and buffaloes among certain Brahmans.

RAI BAHADUR HIRALAL, Jubbalpore.

Customs of Śrīmālī Brahmans, killing a symbolic buffalo, Kalanki Brahmans killing a cow and other Brahmans pigs shown. The details show these to be relics of human sacrifices, for which a sister's son from amongst the relatives was apparently the best available victim.

51. Two types of sedentary games prevalent in British Garhwal.

H. C. DAS-GUPTA, Calcutta.

In this paper the author has described two types of games. One of them—*bagh-bátti* is a type of tiger-play and the other—*bheri-bakri* is a type of game with two kinds of pieces the movement of which is regulated by the throw of 4 pieces of cowries.

52. A short account of The International Conference of Anthropology at Amsterdam.

J. H. HUTTON, Naga Hills.

Dr. Hutton represented India at the International Conference of Anthropology which took place recently at Amsterdam. He will give the members of the Indian Science Congress an idea of the main things done in this Conference.

53. Bhumij Terminology of Relationship.

TARAK CHANDRA DAS, Calcutta.

It gives a list of the terms of relationship used by the Bhumij—a tribe of Chota Nagpur, Orissa Feudatory States and Western Bengal—, with an attempt to reconstruct the social background which made possible the growth of these terms.

Section of Psychology.

President :—MICHAEL P. WEST, M.A., D.PH. (OXON.).

Presidential Address.

PSYCHOLOGY AND EDUCATION.

I thank you for the honour which you have done me in electing me your president; but I confess that I feel acutely conscious of the difficulty of the task which you have imposed upon me,—namely, to deliver an address in succession to such varied masters of the subject as Dr. Sen Gupta, Mr. Haridas Bhattacharya, and Lt.-Col. Berkeley Hill. I came to this Congress rather as a schoolmaster than as a psychologist; I came to learn from you rather than to address you, to gather ideas which may be put into practice.

I have thought this, therefore, a fitting occasion on which to discuss with you the relationship of our respective sciences, the relation of psychology and education.

Let us review the matter first rather from the point of view of the psychologist.

The earliest educational psychologists were, for the most part, philosophers, or theologians also. They had, as a result of a study of human nature and its needs, evolved some theory as to what man is and what he ought to be; and, as true experimental psychologists, they went to the school to realise or to try out their ideal. So Aristotle goes to the school to realise his ideal of the perfect citizen, Quinctilian to realise the perfect orator, the Monastic Orders to realise the perfect ascetic, Chivalry to mould its 'very perfect knight,' the Jesuits to shape the disciplined missionary, Comenius to build his 'Pansophic' society; so also Arnold to make his 'Rugby boy,' and Spencer to create his Scientist-citizens.

All these, in spite of their wide range of dates, have one characteristic in common: they all desire to mould the child to a definite type. They emphasise education as the production of conformity.

Now we find a second school of educational theory which emphasises a quite different point of view. This school may be typified by Erasmus, Vittorino da Feltre, Ratke, Pestalozzi, Froebel. It tends to emphasise the nature of the material rather than the form to which it is to be shaped. Education is not a moulding, according to them but a growth; and the psychologist is invited to cooperate with the educationist by describing the laws, or types, or main stages of mental

growth in the child, in order that the schoolmaster may design his education according to nature.

From natural education it is not a very long step to individual education. The pioneers of the Child Study movement, Preyer, Sully, Stanley Hall and others, accumulated a vast treasury of observation, replies to questionnaires, children's diaries, and so on, illustrating the nature and growth of the child. It will be noticed that the books of these writers are all of considerable size. But, when one proceeds to condense them, in order to reach a skeleton of principles on which to build a system of educations—they disintegrate. The various observations have this in common that at the age of adolescence certain physical changes take place which are accompanied (as one would expect) by certain mental changes—but these mental changes vary enormously from one child to another. And we learn that in all other respects children are different, very different, distressingly different. They refuse to 'boil down.'

The obvious deduction to be drawn from this is that natural education is individual education. Since children are so individual they should be allowed to grow up as individuals. Education, then, is a realization of individuality.

We have thus reached the precise antithesis of the first ideal of education. The school of educational thought which we first described, emphasised conformity to type; this second school of thought emphasises the realization of individuality.

The main purpose of my address to you today is to suggest that both of these theories are in their way and in their place, correct; but that neither is of very much use to the schoolmaster; nor is any theorizing likely to be of use to him which is done in the study, away from the concrete difficulties and practicabilities of the school. The real problem of educational psychology is not what education should do, but what the school *can* do, and how it is to do it.

Now one very obvious aim of education is that children should become adapted to the world in which they are to live. I ask you to lay aside your psychological theory for the moment and consider this simple purpose from the point of view of the schoolmaster who is called upon to fulfil it. The problem of the schoolmaster is very simple:—I should say rather that it may be very simply expressed. He is required to take infinitely variable human material, combine it into a class, and adapt it individually to an infinitely varied world.

The schoolmaster applied to the psychologist for guidance as to how best he might fulfil this task,—for apparently it would involve teaching all the subjects in the world to every conceivable type of child. The advice of the psychologist was that schooling should be rather a development of powers than a teaching of specific subjects: it is obviously not possible to teach all subjects to all boys, but it is possible so to develop the

powers or faculties of every boy that he may be capable of dealing with any subject which may eventually arise in his individual life.

It is difficult to realise how vast and how malign has been the influence upon educational practice of this doctrine of Transference of Training to the Faculty theory. The theory has become so deeply rooted that even now, when it is universally acknowledged to be unsound, yet it is hardly possible to take up any general writing on the subject of education or to listen to any popular speech on the subject of education without encountering it. And it is quite impossible to justify most of our actual present practice in the schools without relying on it.

It was assumed that the results of a general training applied to certain mental faculties (themselves merely verbal abstractions of the psychologist) would be transferred to each specific mental activity in those faculties. Thus the memory training might be supplied by a course of Latin. So reasoning also might be developed by a course of Euclidean Geometry; and in the same way, every subject in the curriculum could be justified on psychological grounds by its effect upon some faculty or other.

No other possible reason save this can be found for teaching Sanskrit to Bengali school boys in the manner in which it is taught to-day; for the course and the method of teaching are so ingeniously designed that it is absolutely impossible for any boy, in the time allowed for the course, to achieve any single usable function in the language. No other possible reason or excuse can be urged for the teaching of Geometry as it is taught today, unless it be some supposed training of the faculties. The boys learn the most abstruse Euclidean reasoning and leave school unable to measure the area of their own fields. Our present curriculum is cankered through and through with this vicious theory. The popular mind is touched with the same infection; and the schoolmaster clings to his faculties as pertinaceously as a drowning sailor to his raft.

For years he has taught in his school what he himself happened to know, that is what he himself had been taught; and has justified it as 'developing the faculties.' As a natural result of this heriditary method of framing it, the curriculum now dates back to the middle ages (when first this idea of faculties was given to him). But this mediæval curriculum is not considered obsolete,—for it develops the 'faculities' for dealing with the modern world.

James showed that the effect of such transference of the effect of learning was negligible; but no one took any notice. Dr. Sleight, both by his own experiments and by his brilliant summary of the whole subject, has laid bare the barrenness of the theory beyond all disputation: but there has been no striking or immediate change in educational practice as a result.

All that there has been is some feverish attempt to find new reasons for teaching the old things in the old way.

The fact is that the schoolmaster dare not admit that the faculty theory is invalid. Such an admission would plunge the world back for him into its 'buzzing confusion.' He would have to teach things for themselves! useful things! things of to-day!—He would have to combine infinitely variable human material into a class and adapt it to an infinitely varied world. It was to find a way of escape from this very problem that he went to the psychologist. The psychologist has deserted him: he cannot afford to admit the desertion.

* * *

As regards the problem of the variety of his pupils, the schoolmaster has for the most part been content to do his best. He has aimed at producing the type, the public school type, or the some-other-sort-of school type. And if certain pupils proved intractable, he has been content to answer that the child did not suit the school, rather than that the school had failed to adapt itself to the child.

Of late, however, there has been a protest against this simple and practical solution of the problem, a recrudescence of the theory of 'guided individual growth' and of the demand for individual attention.

This theory of individual attention is not, as we have already shown, in any sense a new one. It was propounded by Vittorino da Feltre, by Ratke, Erasmus, Locke, as well as by Froebel and Pestalozzi. Vittorino was a court tutor with a few lordlings as his pupils. Locke was much the same. Ratke, given a school of five hundred children, made a sorry mess of it. And as for Froebel and Pestalozzi,—infant classes are always smaller than the others, and the infant teacher teaches only one class instead of one subject throughout the school.

You will notice on school prospectuses, that when the school is small and struggling it advertises "individual attention," but when it gets bigger, that is changed into a swimming bath or gymnasium.

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Such then is the present situation. The school solved the problem of unlimited variety in the curriculum by means of the doctrine of faculties. But this prop has now been taken away. It solved the problem of unlimited variety in the pupil by throwing the responsibility back on the parent—if the child did not suit the school he might try another; but now the schoolmaster is supposed to suit the school to the child, and to give individual attention.

In fact the school has lost all its psychological props. The schoolmaster no longer knows what to do, and sometimes

he is inclined to lose his temper and say, "If every child is to study a different subject, and every child is to be treated as if he were the only boy in the school,—then why have schools at all? Why not private tutors and correspondence courses?"

Having brought my subject to this pass, I feel that I am called upon to suggest something in the nature of a *denouement.*

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There has always been some subtle connexion between psychology and magic. In the old days people bought Love Potions; nowadays they buy a book on the "Psychology of Personality." These popular psychologies of will power, salesmanship, and so on, appeal to just the same motive which supported wizards—the old infantile wish to get something done without the trouble of doing it.

It was in just this same spirit that the schoolmaster approached the psychologist, "Give me some magic which will enable me to fulfil this impossible task of teaching a class of infinitely different children the infinite variety of the world." The psychologist served out to him one of those Philtres or Potions to which I have already referred. And when it did not work he blamed the schoolmaster's method of administering it. (Herein we find the origin of Training Colleges.)

It does not seem to have occurred to anyone that the schoolmaster is not a magician either.

And yet he is treated as one.

He is expected to give individual attention, more skilled than that of a father and mother, to the hundred or more children whom he has to teach. Surely the individual attention of the child's own father and mother must necessarily be more sympathetic, more fully understanding than that of an outsider who has not had the advantage of seeing the child grow up from infancy, and of knowing the ancestors whose traits are reproduced in him.

Parents cannot be bothered to attend to their own children, so they pay the hundredth part of a schoolmaster to do the work for them; and they expect him, thanks to the help of the psychologist, to understand the children better than their own parents.

Cheap magic is what they are asking for.

The school is expected to show the child all the kingdoms of the earth, its governments and its municipalities, its manufactures and its offices, its mountains, rivers and ancient cities: thus, knowing the real world in which the parents live, the children will, when the time comes, be ready to step into their shoes.—It does not occur to the parents that they are living in this world of theirs very much more really than the schoolmaster is. Is not the father a member of the munici-

pality? Has he not got an office? Does he never go on a holiday to 'mountains, rivers or ancient cities'?

The best education a child can receive is to be given some insight into the life of his own father.

In the good old days before schools were invented, the father found his growing son a very congenial playmate, and a useful helper. He took him out fishing with him; he made him hold the arrows when he went stalking; he made him bind the sheaves. By a natural apprenticeship the son learned the craft and the hobbies of his father. There is in most men an innate pedagogic instinct, which yields some pleasure in "teaching the young idea how to shoot": men in those days liked to show their sons how clever they were; and to tell their friends how clever their sons were.—But this instinct seems to be dying away, like many of our more manly instincts, under the influence of the artifices of civilization. The modern father does not go stalking or reaping, but he does many other interesting things both of work and of play. To the young all the real world in which his parents live, is interesting. But the attitude of the civilised father is, "Why should I educate my son when I am paying a teacher four rupees a month to do it?" He does not discuss the newspaper with his son; he is careful not to mention the office when he comes home to tea; he does not take his son with him when he goes out to a meeting. Then one day he asks his son a few "General Knowledge" questions about the world in which he, the parent, is living, such as "Who is the Governor? What are rates? What does crossing a cheque mean?" And, when the boy cannot answer, he says, "Good God, what am I paying four rupees a month for!"

At its best the school deals with children in the mass and with the elementary common necessities of knowledge. Even the wisest of headmasters cannot know his children as their parents do, nor initiate them as closely into his own experience of real life as the girl's mother and the boy's father can do. The most intimate things, the most individual things, the most real things must come from the Home. They are not amenable to the mass methods of the school.

It seems strange to have to remind people that the making of children is essentially a home industry.

What then is the function of the school?—Its function is to do those things which the home cannot do, to teach those things which the home cannot teach, to supply those facilities for self-development which the home cannot supply.

First and foremost it has to teach the child the little conformities and necessities which are common to all. The home cannot teach a child that he is not the only pebble on the beach, that he must conform to custom, be punctual, hide his feelings, not make a fuss and in general adapt himself and

learn to live with other people. The home has not the pressure of numbers to teach these things. It is just because the school *cannot* individualise that it teaches the boy to fit into a world which is far less able to do so. (By this I do not mean that the schoolmaster is not to know his pupils individually nor help each in his individual difficulties, but I mean that his lesson is not essentially an individual one. His function is to teach the boy the art of living as one among many).

Secondly, it is the function of the school to teach the child as economically and as effectively as possible certain knowledge and skills which are necessary to all. It is here that we come to blows with the individual psychologist who emphasises education as a process of free and natural growth. So it may be, in some things; but the child has got to learn his arithmetic, and write a decent hand, and spell in the conventional way. I have visited a number of schools founded to embody all those attractive ideals of education as free and individual growth. They have many merits; but they all seem to be weak in arithmetic.

There is a third function of education which is commonly attributed to the school, namely, the education of the child in the cultured use of leisure. The man has his home, his office and his club. So also the child has his home, his school (where he learns the necessary things); and there ought to be some place where he can develop his own tastes and cultivate himself in his leisure time. We need a sort of club-school, a youthful society in which each may discover what forms of culture satisfy him best, and co-operatively develop himself in those things. The psychology of such an institution is essentially the psychology of play.

* * * * *

Where then should the school ask for the help of the psychologist ?

The Institute of Industrial Psychology under Dr. C. S. Myers sends expert psychologists to investigate the methods of factories. They work in the factories as ordinary 'hands,' and see by what means production may be increased, and fatigue or accidents lessened.

The Educational Psychologist should come into the schools and work alongside like that, tell what things the schoolmaster can reasonably expect to be able to do, and how he may do these things better and with less wasted energy of child and of teacher.

There are, as I suggested in my paper to this Congress last year, three processes in such an investigation. The first is psychological analysis of the function aimed at. The second is exact measurement of the result attained. With the help

of these two the third process may be performed, namely, the perfecting of a practicable and economical system for producing the result required.

The earliest application of this system of investigation to school problems was made by Rice in 1897. He analysed what spelling ability the child needs in real life; he endeavoured to measure that ability, and to devise a system of producing that ability. The outcome of his research has been word-frequency list, and the modern system of teaching spelling. If one looks at a spelling book of the last generation one cannot but realise what an incalculable number of wasted hours of futile labour has been saved by this simple pioneer investigation.

Life demands rapid and legible handwriting. The copy-book is not rapid: hence the child reserves one form of response for his writing lesson and a very different form for all his 'real' writing. Thus the web of Penelope woven by the writing master was ten times unravelled during the rest of the day. The Ayres and the Thorndike writing scales supplied a means of measuring speed and quality of handwriting. With the help of these instruments Freeman has been able to raise the practice system in this subject perhaps to a higher level of scientific efficiency than that of any other subject in the curriculum.

Courtis and others drew attention to the extreme importance in life of speed and accuracy in the four fundamental processes of arithmetic. The Courtis Tests have measured these functions, and the Courtis Practice system provides a most ingenious and effective method of producing the functions required. This piece of work is however an illustration of the importance of clearness of vision in the preliminary analysis. Life does not demand 'speed and accuracy' in these processes in the sense of two variables. It demands cent. per cent. accuracy combined with an adequate degree of speed. Babu Aswini Kumar Dutt has found that the demand for cent. per cent. accuracy very greatly alters the whole conditions and results of the test, and of the practice system.

Prof. Thorndike, the greatest figure in this field of research, has made a brilliant analysis of the teaching of problems in Arithmetic. Following the lead there given, Babu Jogendra Bannerjee is endeavouring to discover, as a basis for the construction of a curriculum, what types of problem occur most widely in actual life. The requirements must, of course, vary greatly in different localities and in different professions. It remains to be discovered what common substratum is really needed by all, and what specific adaptations are needed in particular instances.

The number of attempts to measure reading ability is legion. The tests themselves show the greatest confusion as

to purpose. Some are no more than intelligence tests under another name, and are likely to be a far more effective indication of natural growth than of the success of the teacher's efforts. Others demand the type of reading used by a lawyer in studying a brief and expect the child to apply that to a simple fairy tale which any sensible child would merely skim. We have endeavoured at Dacca to analyse what is the type of reading most commonly used in actual life, to measure it, and to devise a system of training which will produce it. We have met with some success: but the Matriculation examination is an insuperable obstacle to the application of our methods in the schools.

In foreign languages a courageous attack has been launched by the Committee on Foreign Languages in America and Canada. Their recently published report gives the results of the most extensive measurement yet made of the effects of foreign language teaching in schools.

Measurement of foreign language ability have been made in Dacca and in Calcutta during the past six years; and we have been able to apply some of the principles thus discovered to the problem of teaching reading in a foreign language. The system of teaching thus evolved is now being adopted in other countries, Ceylon, Egypt, Africa and elsewhere.

This brief review of what has been done serves only to accentuate the magnitude of the task which yet remains. The field open to such research is unbounded. The promised harvest in increased ease and efficiency of learning in future generations is unbounded.—But the workers are few.

This paucity of workers is not due to any unfavourableness of conditions in this country. On the contrary there is no country in the world in which conditions are more favourable for this type of work. There is no country in the world in which schools are more willing and anxious to help in such investigations. A distinguished British psychologist spoke with envy of the opportunities which we have in this respect. There is no country in the world in which clerical labour for digesting the statistical results of measurements is so readily obtainable as in India; nor is there any worker who has a greater gift of patience. Lastly there is no country in which printing is cheaper—a very important factor.

And yet we find year after year young Indian students going to take their M.Ed. in Leeds, or in Sheffield, or in Manchester. I was shown recently in England a thesis on a most important and fascinating subject—the Physical Training of Bengalis—a wonderful field for objective research and practical experiment. But this thesis had for the most part been composed in—The British Museum!

There is no degree of M.Ed. in Calcutta. Only one candidate has as yet appeared for the degree in Dacca. The

Indian student prefers to study the needs of his country in the British Museum.

* * * * *

We have said nothing yet in regard to that third function of the school, the cultivation of leisure, save that its psychology is the psychology of play.

I think that most of you will agree that of all the sections in an average text-book of educational psychology that on play is the least satisfactory. And of all the features of the average school this feature is probably the least satisfactory.

There are many adults of our acquaintance, respectable men, cultured men, who cannot draw or paint, and take no pleasure in attempting to do so; others who have no interest in music; others who never read poetry. There are good athletes who do not play football; there are intelligent men who are not interested in nature study. There are cultured men who, beyond the common necessary knowledge, have no enthusiasm for history.

There are certain leisure subjects. I do not mean that they are pursued in a leisurely way—far from it; but that they are essentially a matter of choice and enjoyment. But the school has made them compulsory. And the very fact that they are compulsory, and that they are taught in the same atmosphere as the arithmetic and the spelling lesson destroys every atom of their essential character.

Now these leisure subjects are not trivial things. To the psychologist most of all they are very important things. Just because they imply an element of choice and of natural inclination they enable children to differentiate themselves: and these automatically developed differences determine the child's future occupation and place in the world.

By a brilliant inspiration the schoolmaster has made them compulsory and the University or the Department has set a pass examination at the end of the course. They have ceased to be leisure subjects: they have ceased to form interests: they have ceased to differentiate.

And then the psychologist with his Vocational Tests has to be called in to sort the children to suitable occupations, whom the school has so brilliantly prevented from sorting themselves.

The assistance of the psychologist should be used in this case not as an after-math in remedying the harm which the schoolmaster has done, but rather in the first instance in helping to evolve a new type of institution which shall make vocational tests unnecessary. It should be an institution giving the children the widest possible opportunity of being as different from each other as possible. There is something of this type of educational institution in Oxford University, in

Gilwell Park, in the Y.M.C.A., in a Night Technical School—places where you can do what you like so long as you do it with a will. It should be like the bacteriologist's *agar-agar* on which the germs of dispositions may develop and reveal themselves to the psychologist—and to the child's parents.

* * * * *

I have shown you two diametrically opposed schools of educational psychology, the one emphasising the type, the other emphasising individual growth.

The essential function of the school as it exists today is to produce conformity and to teach those elements of knowledge and skill which are the common need of all. The function of educational psychology here is to make the process of learning these necessary things as efficient as possible, by analysing the need, by devising the process of learning and by measuring the result. The more efficiently and expeditiously we are able to dispose of this uniform and inevitable part of education, the more time and energy will remain for the free and more self-satisfying part.

There is need of quite a different type of institution from the first, namely, one which shall give to the growing child the means and the opportunities for developing his own peculiar interests. The more advanced experimental schools of the present day tend in this direction,—the Caldecott Community and Caldwell Cook's classes. But for myself, I doubt whether it should be called a school, save for mere etymology. I am doubtful whether it should even be in the same building. It would perhaps be better to leave the traditional type of school to fulfil its traditional, and very necessary, function; and to develop this new type of institution untramelled by precedents which are so far opposed to its nature and purpose.

Man's essentially constructive mind in the past found a greater affinity to the work of a potter than to that of a gardener in education. Later there was a reaction to liberty and individuality. In some ways this has been found to be a misguided reaction. And now education is in a state of flux ; and educational psychology no less so.

It is the task of the future, a task in which the schoolmaster and the psychologist and the parent must cooperate, to reconcile and to delimit the spheres of these two equally necessary purposes in education.

There is no country which has greater opportunities than India of contributing to this work—if it will but use them.

Section of Psychology.

Abstracts.

1. A note on some recent studies on attention.

N. N. SEN GUPTA, Calcutta.

Various phases of the attentional process have been investigated during the last few years. The notions of 'Range' and 'Degree,' as a consequence, demand revision. Secondly, the Gestalt School has pointed out a number of theoretic anomalies in the concept of attention. The paper presents an account of the attentional process in the light of these researches.

2. The concept of instinct since 1920.

S. C. MITRA, Calcutta.

Ancient theological view. Survival of it in mediæval times. Darwin and Wallace. Biological views. James and Schneider. Psychological views. Loose use of the term. Development of comparative psychology. Search for a physiological basis. Compound Reflex theories. Conscious correlate taken into account. MacDougall, *etc.* Need we retain the term Instinct in Psychology ? The present conflict. Ayres, Kuo, *etc.* The Gestalt school. The assertion of the unity. Contributions made by abnormal psychology. Difficulty of disintegration. The modern social scientists. Bernard, *etc.*

3. The influence of attitude on the length of reaction-time.

GOPESWAR PAL, Calcutta.

Reaction-time experiment has a dual value—psychophysical and psychological. Much attention has been directed to the psychophysical, but the psychological aspect is somewhat neglected. The present experiment was undertaken for a thorough-going introspective study of reaction-consciousness. The analysis of action-consciousness of four highly trained subjects are examined. The examination reveals that (i) the three classifications of R. T., e.g., muscular, sensorial and natural do not stand, (ii) difference in length of R. T. depends on the subjective or objective attitude of the reactor, i.e., R. T. varies according as the subject's attention is directed to subjective phase of the perception of the stimulus or to the objective phase, (iii) R. T. in the objective attitude is shorter than that in the subjective attitude, (iv) Stimulus may affect the observer in one of the four following ways:—(a) Passive subjective way, (b) Active subjective way, (c) Passive objective way, (d) Active objective way; (v) Long practice is required to develop the proper condition in the subject under which either the objective or the subjective phase in a pure form is appreciated. The stimulus affects the observer often subjectively and objectively in succession, though the observer takes up one particular attitude; (vi) The length of R. T. varies with each different 'affection.'

4. Nature of colour experience of a partial colour-blind subject.

GOPESWAR PAL, Calcutta.

The subject was unaware of his defect until tested. He was examined by three principal tests, e.g., colour-naming, colour-matching and colour-equations and by other minor tests. His colour nomenclature is constant. Red, Brown, Dark Orange, Dark Blue, Green, he calls Red, Scarlet, Pink, Blue, Violet, he calls Blue. Yellow-green, Orange, Yellow, he calls Yellow. Orange, Dark Yellow, Yellow-Green, Green, Blue-green, he calls Orange. He has no name for pale Blue-green and Red-Orange. In his Colour Vocabulary, " Yellow " and " Blue " predominate.

In matching colours he confuses Green with Yellow-green, Yellow-red with Dark-Yellow; Red with Dark-Brown, and Dark Blue-green; Blue-Green with Green, Yellow-green; Yellow-red with Red; Yellow-green with Red-yellow and Dark-yellow; Violet with Blue; Pink with Blue, Pale Violet with Pale Blue-green; Brown with Dark Blue-green and Green. Vivid Red is better recognised than Vivid Green.

Ten Colour-equations were tried. The equations of the subject indicate that Yellow and Blue are two colours from which every other colour is derived. Red, Orange, Yellow and Green are seen as shades of Yellow. Blue-green forms the neutral band. The rest of the Spectrum is seen as shades of Blue. The Violet end is seen as Black.

5. Mechanism of 'Bad' memory.

HARIPADA MAITI, Calcutta.

A group of students was divided into two classes of good and bad memorisers in terms of (1) the time taken completely to memorise a series of nonsense syllables *and* (2) the degree of 'saving' in this time after the lapse of a certain time-interval. The correlations are studied. Characteristic features of reproductions as well as errors committed by the two classes of memorisers are analysed. This analysis is compared with the introspective reports of the subjects.

6. The effect of rest-pauses on stimulation and fatigue.

D. N. SEN, Patna.

1. *In sense stimulation :—*

The psychogalvanic method has yielded important results as reflexes of sense stimulation. I have obtained complete fatigue curves for smell, taste and light.

The experimental arrangement.

(*a*) Apparatus used :—A highly sensitive galvanometer with non-polarisable electrodes dipped in non-conducting dishes containing saline solution in which fingers are plunged for completing the circuit, the subject being insulated to prevent leakage through contact with the ground.

(*b*) The experimental operation :—If two skin points are put in contact with the terminals in the galvanometric circuit a current is produced. If, after this, no stimulus is applied and the subject remains quiet, the spot of light returns to zero. A stimulus is now applied. This stimulus may be physical or psycho-physical and elicits an appropriate response. I have tried both physical and psycho-physical stimulation successfully, and when continued sufficiently long they have given complete fatigue curves for the excitation of the senses or of the brain.

(*c*) Results :—When rest pauses are interposed at the time when stimulation is at an end and the curve begins to descend to the fatigue point, it has been found that the result is a long and slow descending

curve and it is even possible to avoid positive fatigue for an indefinite length of time.

2. *In brain stimulation* :—

The result is similar in brain stimulation, when for example a piece of mental work is given such as mathematical calculation, the fatigue curve takes the same course. The psycho-circulatory method proves the same fact. The reduction of arterial pressure as indicated in the radial pulse is very much reduced when fatigue ensues. But by interposing rests the on-coming of fatigue can be resisted successfully.

7. On the visual perception of complete geometrical figures.

M. L. GANGULY, Calcutta.

Incomplete geometrical figures are sometimes perceived as complete. On what does it depend ? Circles of different diameters and squares of different sizes are experimented upon. The figures are of various degrees of incompleteness. The limits where incomplete figures are perceived as complete are sought to be determined in this paper.

8. Two dreams of an ascetic disciple.

SARASI LAL SARKAR, Noakhali.

The writer has dealt with two dreams of Kuladananda Brahma chary, an ascetic disciple, while he was trying to attain Brahmacharya or freedom from sexual feelings. The writer has tried to show that there is a mechanism for sublimation of sexual feeling in the human mind, which comes into operation at the time of the passing of the Oedipus complex, as has been shown by Sgm. Freud. The dreams considered above show that the same mechanism is utilized by the mystics for the sublimation of the sexual feelings.

These dreams further tend to show that for sublimation, the sexual feelings are separated into two elements, *viz* : purely sexual and æsthetic. The former is abrogated. The second is introjected into the ego and forms the kernel of super-ego.

9. Psychological anæsthesis.

S. SANKARA MENON, Trivandrum.

The paper discusses the theory underlying "suggestion." Psychological anæsthesis goes to show that it is possible to transmit a depressent suggestion to a subject. The suggestion appears as it were a stimulus producing a response in the subject by his becoming amenable to the suggestion. The author thinks that the forces underlying suggestion have polarity and direction. He also discusses the theory from the view point of Indian Psychologists.

10. Psychology of dreams.

R. NAGA RAJA SARMA, Madras.

The starting point for the discussion is the conclusion arrived at in the paper contributed to the Psychology Section of the Ind. Science Congress of last year, that the Upanishadic theory of dreams is less risky than that formulated by Freud. (2) Statement of the theory advanced by Dr. Rivers that dreams are attempts to solve in sleep those conflicts which are disturbing waking life. (3) Criticism of the theory that in several dreams conflicts are not solved. In fact there is no reference to any conflict at all. (4) Examination of some representative Upanishadic texts. (5) The theory of the Vâsanâs being responsible for the creation and projection

of dream-life. (6) The creative activity of the mind playing upon the Vâsanâs is responsible for dreams. (7) There are several dreams in which neither wishes are fulfilled nor conflicts solved. (8) Reference to the hypothesis formulated by MacCurdy that dreams are to be regarded in the same way as symptoms in manic-depressive insanity. (9) Transition from the waking *via* sleep into the dream-world and progress thence to the waking state. (10) Perfect adjustment to waking life with a thorough understanding of its significance and its limitations, in short life according to the ideal of Vairagya would free the subject from the vâsanâ-engendered dream-life, pleasant and unpleasant.

11. The problem of Hindu-Moslem unity from the psychological standpoint.

HARIPADA MAITI, Calcutta.

The meaning of the unity desired to be established. The present attitude of mutual hatred and suspicion existing between the two communities. Theory of the unconscious in explanation of this attitude. Mechanism of projection. Psychology of social groups, natural and artificial. Identification as the psychological basis of unity. Conditions of identification and suggestions for increasing it.

12. The sign language of deaf mutes.

HEM CHANDRA BANERJEE, Dacca.

(Communicated by Dr. Michael West.)

(1) The deaf-mutes' natural method of communication is the language of signs. Most of these represent some distinctive suggestion of the action or the shape or some characteristic of the object or idea which they are intended to signify. They have no fixed connection with the actual words used as equivalent: *e.g.* (*a*) *Goat*—"A pronam—palms together, hands raised to forehead, then hands, palms together brought sharply down."

(2) This sign language though much used in the 18th and 19th centuries in Dumb Schools, is now a forbidden language, because—

(*a*) it is intelligible to very few outside the institution
and (*b*) oral speech is more useful in after life.

(3) An investigation was made in the schools for the Deaf and Dumb in Calcutta, Dacca and Barisal. A comparative study of the symbols has been given.

(4) It will be seen that some of these signs have undergone local changes so that the different parts of the country have different signs to express the same idea, *e.g.*, the signs for 'Yesterday.' Moreover one sign giving one idea may be translated into different words under different circumstances, *e.g.*, the sign for 'Thirst'—'drinking sign and stroke neck' may mean thirst, thirsty, feeling thirsty and so on.

In spite of its incompleteness and imperfection the interest of the sign language of the deaf-mutes is due to—

(*a*) The Behaviourist theory of the relation of speech mechanisms to thought according to which 'thought is the action of the language mechanisms.'

(*b*) Its practical importance in the teaching of language—since by means of such sign languages it is possible to give rise to an idea in the child's mind directly without bringing in any other spoken language: hence the child's speech in the foreign language is not contaminated by false bilingual equations introduced in the use of the mother-tongue.

13. Intelligence tests in Bengal.

ASWINI KUMAR DATTA *and* DR. MICHAEL WEST, Dacca.

All English and American tests require a great deal of adaptation for use in India,—so much so that in most cases the results of the test applied to Indian children would not be comparable with English results.

Intelligence tests for children are not much needed in India, and are very difficult to use owing to the difficulty of discovering the truê age.

Adult tests are likely to be very useful, as a means for selecting candidates for admission to technical and professional colleges. Such tests will naturally tend to be of a partially 'vocational' nature.

14. Intelligence tests.

M. J. MUKHERJEA, Agra.

The paper reviews the present situation in the study of intelligence tests. The Binet Simon tests are criticised, and the value of the system is emphasised. The adaptation of group tests and performance tests to Indian conditions is discussed. Suggestions are made whereby such tests may be made more useful and more widely used in India.

15 Objective examinations.

ASWINI KUMAR DATTA.

(*Communicated by Dr. Michael West.*)

The fluctuating and subjective nature of a judgment on an essay was illustrated by the results of the experiments communicated to the last Ind. Science Congress. Now it is evident that the marking of every examination into which composition enters must to some extent be vitiated in the same way as is the marking of the essay itself. The written examination in present practice usually consists of from five to ten questions and these questions are really so many short essays. The man who marks an examination paper in history marks *power of essay writing* as well as *history*. He is unconsciously influenced by the handwriting, the spelling, the appropriateness of wording and many other adventitious things. The correlation between two independent appraisals of any set of papers is never very high.

Experiments were conducted with a new-type of examination which may be called objective examination, for a large part of the purpose in employing this new technique is to make the marking of the pupils' response objective, *i.e.*, independent of the teacher's personal judgment. The use of a large number of small questions of a type that would allow objective marking and the very small amount of writing demanded are the characteristics of this examination. Objective examinations were given to classes IX, VIII and V of two High Schools in English, History, Geography and Mathematics immediately after the usual annual examinations. The average correlation between the annual examination total and the objective examination total in these four subjects was 0·81, P.E. 0·05. The correlations in different subjects ranged from 0.52 to 0.78. The intercorrelation of the independent examiners in the objective examination was 0.97. The intercorrelation of independent examiners of essays ranged from 0.27 to 0.76 and of the examination of the essay type from 0·6 to 0·85.

16. Relative importance of arithmetical processes in real life.

D. K. CHAKRAVARTY *and* J. C. BANNERJEE, Dacca.

(*Communicated by Dr. Michael West.*)

A questionnaire containing the various processes (omitting the four

fundamental rules which were taken for granted as essential) with illustrative examples was distributed among persons engaged in various occupations. They were asked to grade the processes according to their relative utility and importance in their own occupations. One hundred and forty-six replies were received. The order of the processes is as follows :—

1. Simple Interest.
2. Simple Practice.
3. Profit and Loss.
4. Percentages.
5. Rule of Three.
6. Averages.
7. Compound Practice.
8. Commissions.
9. Unitary Method.
10. Vulgar Fractions.
11. Decimal Fractions.
12. Exchange.
13. Compound Interest.
14. Brokerage.
15. Square Measure.
16. Ratio and Proportion.
17. Premium.
18. Shares.
19. Cubic Measure.
20. Square Root.
21. Discount
22. Present Worth.
23. Stocks.
24. Recurring Decimals.

A further investigation is being made with the intention of obtaining a larger and more representative vote. The vote thus obtained will be weighted by the proportion of each occupation in the total population as shown by the Census.

17. Influence of sensory stimulus upon muscular work.

SUHRIT CHANDRA SINHA *and* MADHUSUDHAN GHOSE.

Féré found that every sensory stimulus led to an increase in the output of muscular work under certain conditions. This phenomenon was termed by him "The dynamogenic effect of sensations." The paper presents the data of a series of experiments carried on in order to verify Féré's results. It reports the data obtained by a number of appliances and with a variety of sensory stimuli.

18. Influence of modes of presentation on memorisation

S. K. BOSE, Calcutta.

The paper presents the results of two sets of experiments on the process of memorization using two different modes of presentation. In one set the 'nonsense' syllables were presented in a continuously moving series, while in the other set they moved with jerks (as in the Jastrow memory apparatus). The relatively higher score with the former method tends to show its relative advantage.

19. A statistical study of action evaluation.

G. HANUMANTHA RAO, Mysore.

The test employed is Koh's Action Evaluation Test (modified). It was given to three groups of students of different ages and grades of education—B.T., First year B.A., and Form. IV. Though there is considerable agreement between the judgments of the three groups, each group presents a different degree of variation. The amount of error varies inversely with advancement in age and education; the error being greatest in the Form IV group and least in the B.T. group. This leads one to think that the test may be of much use in detecting young delinquents, potential or actual. Verification of this hypothesis is in progress and data bearing on it are invited.

It is generally believed that when words like 'bigamy', 'stubborn' are given for evaluation, they will be placed under one or two of the following six heads included in the test-Praise, Do Nothing, Fine, Jail,

Execute. But as a matter of fact, we find that each of them is placed in no less than five out of the given six heads. This runs counter to the assumption of moralists and legalists that men are aware not only that an act is vicious but also how vicious it is. Thus, for example, out of the 120 subjects tested, 1 subject places Bigamy under 'Praise', 24 under 'Do Nothing', 63 under 'Scold', 16 under 'Fine', and 15 under 'Jail'. It is further seen that in many instances the opinion of the man in the street is much at variance with that of the legal expert. The test needs a few corrections and additions and given in its modified form to subjects of different nationalities, it will bring out many interesting national and racial differences. This and the other line of investigation mentioned above are in progress and will be reported when they are completed.

20. The sense of the incomplete.

H. D. Bhattacharyya, Dacca.

The human mind is not only subject to what may be called an absolute imperfection in all fields of thought and action, but also suffers from three different kinds of relative imperfection. These are want of æsthetic fulness (in its twofold aspect of the balanced and the unified), want of periodicity, and want of continuity. Many personal and social beliefs and superstitions owe their origin to the sense of the incomplete in one or other of its varieties. A detailed analysis of the psychology of numbers is given under the second heading.

21. Introversion and extroversion.

J. K. Sarkar, Muzaffarpur.

The common supposition that the poverty and excess of affect are respectively at the root of introversion and extroversion is not well-founded. Jung's view that undifferentiated, or raw, feeling is responsible for introversion cannot be accepted without modification. In fact, this paper is suggestive of the view that the introvert type displays as much emotion as the extrovert type. The real distinction between introversion and extroversion as complex-like mechanisms is that of attitudes of the individual towards objects or situations.

The view suggested above can be demonstrated by a critical examination of the processes of perception, interpretation, and representation. It is also based on personal observation of numerous cases.

22. Blindfold description of Distances.

Manmatha Nath Banerjee.

The paper reports the data of a series of Experiments with 40 male subjects of ages ranging between 6 and 26, with the object of determining the errors in the description of visual distances in terms of movement without visual aid.

The following are some of the principal results :—

1. In blindfold description of distances remarkable improvement is achieved at the second attempt.
2. The deviation error is greater for longer distances.
3. The increase in age tends to decrease the amount of error and its frequency.
4. In nearly 50 per cent. of the trials there was a directional deviation either to the right or to the left. There were twice as many left deviations as there were to the right. The tendencies for directional deviation increase with age.
5. In about 40 per cent. of trials the distances were either exceeded or underdone. The frequency of underestimation was thrice

that for overestimation. The tendency to overestimation is not much influenced by age, while that for underestimation decreases clearly with advancing age. The distance factor tells clearly on the tendency to overestimation but very little on underestimation which generally gains the upper hand.

6. In almost all the cases there is an innate tendency to right oneself by correcting deviation from the true track.

23. Visual Comparison of Areas.

M. N. SAMANTA.

Different geometrical figures experimented upon. Different modes of presentation. Results calculated according to a new method.

24. Working of an Unconscious wish in the Creation of Poetry and Drama.

RANGIN CHANDRA HALDAR.

Poetry or drama have seldom been studied from a psychoanalytical standpoint. The present paper is a psychoanalytical study of poetry and drama of Rabindra Nath Tagore. Beginning with *Shishu* and concluding with *Muktadhara* it takes into purview almost all the artistic creations of the poet. It traces the working of the Oedipus Complex in all its phases in creating poetry and drama. In this connection, an entirely new explanation of mysticism has been put forward by the writer. It also explains the different symbolisms made use of by the poet and shows how these symbolisms are exactly similar to those found in myths, dreams, and neuroses.

25. The Psychology of Scouting.

K. D. GHOSH.

1. Modest beginnings of the Scout Movement in England in 1909 with its aims of character-training and fostering citizenship in boys through their own interests, desires and play impulses a world-wide movement to-day. Over 91% of the world's population have adopted the Scout Programme. What can explain this phenomenal success? To the discerning mind the reasons are fairly obvious.

2. Scouting covering all the stages of boy's life from seven to twenty is a programme that appeals to the boy's paramount instincts, desires and aspirations and a method wholly adapted to the boy's nature and hence admirably suited to kindle his interest and hold his attention. In fact, the whole programme is based on a careful study of the psychology of the adolescent and the pre-adolescent boy and his peculiar and particular needs at each stage. Hence the tremendous appeal of the movement. The importance of Psychology greatly emphasized by the initiator of the movement in his various books.

3. The Chief Scout with his rare psychological insight has found out that play, make-believe or work with elements of play in it have an irresistible appeal to the child throughout this period, *i. e.*, from 7 to 20, specially during the period 7 to 17. And so he proceeds to utilize Play to its fullest possibilities in this his work of developing character and citizenship in boys and girls all over the world. In fact the very origin of the idea of such a movement began in the play impulse of the Chief Scout. (His article "How it all began"). A Psychological consideration of the meaning of play and make-believe. Utilization of play and the other instincts as a motive.

4. Sir Baden's full appreciation of the Boy-nature in general and of

the somewhat different psychology that prevails at different stages of his life from seven to twenty.

A detailed consideration of the physical and mental traits in the boy during the periods, 7 to 12, 12 to 17, 17 to 20 and as to how the Scout Programme provides a different treatment suiting each of these stages by its three divisions, the Wolf Cub Pack, the Scout Troop and the Rovers.

All the important instincts of the child appealed to and guided along lines that develop character and citizenship.

5. The Psychology of the Scout Promise, the Scout Law, and the Scout Discipline, of the Patrol and Six-Systems, of the Grand Howl, the Ritual, the Badges, the Games, the dances, etc.

Character and citizenship follow as bye-products of what the child does and thinks under leadership and association.

6. Want of proper adaptation of the movement to India in certain respects owing to a wrong appreciation of psychological principles.

7. Conclusion.

26. An Analysis of 'Gregariousness.'

K. C. Mukherjee.

Gregariousness is not, as supposed by some psychologists, an unitary instinctive disposition of mind. Sensitiveness to other persons' feelings, the sensitiveness to other persons' opinions and readiness to follow other persons' courses of action are innately given in us and are respectively called 'sympathy', 'suggestibility' and 'imitation'. These are all, no doubt, innate social reactions. It is these innate qualities which make man gregarious. The feeling of uneasiness in isolation is to be regarded as a negative aspect of it.

27. Perception of Temporal Interval as limited by two light stimuli.

S. Sinha *and* S. Bose.

The paper presents a study on the Threshold Value of perception of temporal interval limited by two light stimuli of the same quality and of minimal intensity.

It also reports a preliminary study on the influence of chromatic differences in the limiting stimuli on the threshold value of the perception of interval.

28. Education for Citizenship with special reference to education of adult workers.

J. M. Sen.

Citizenship really means identification of the citizen with the state. When this identification is complete there can arise no question of individual rights, or duties, or privileges. The state then becomes the individual, and the individual the state. We are only part of a nation in so far as we are helping to make that nation, and the power of the state is only derived from the activity of its citizens. The responsibility of the state therefore in the matter of education is great. The paper gives an analysis of the mind of the adult working-class student in India. He has developed habits of thought, points of view and convictions. But these have not been formed on right lines. The education of the working-class student must therefore aim at (1) breaking up poor mental habits, (2) supplementing partial points of views, and (3) correcting false convictions.

29. The Psycho-galvanic Reflex as an Aid to Crime Detection.

M. V. GOPALASWAMI, Mysore.

Introductory.

It is generally agreed that the psycho-galvanic reflex is capable of revealing emotions and mental conflicts, and that any attempt to suppress the emotion tends to produce a *higher* reflex. The present paper reports an attempt to apply this principle to crime detection. With the help of the Mysore Government Police authorities 24 persons arrested on suspicion in connection with various crimes such as, murder, highway robbery, treasury defalcation, and theft, were tested for their emotional reactions to a prepared series of questions, which consisted in the main of two kinds—the *Criminal questions* pertaining to the incidents of the crime, and the *non-criminal questions* relating only to everyday activity.

First Symposium.

30. The Problem of Mental Deficiency in India.

N. N. SEN-GUPTA.

Society has to detect, train, and isolate the ament; also to prevent the propogative of aments. The special difficulties of the problem in India are the wide range, in this country, of the social environment. An ament may be adequately adjusted to a simple village environment yet hopelessly maladjusted to complex social or economic situations. Mental deficiency is often interpreted esoterically; the patient is supposed to be religiously minded. It is also sometimes exploited; idiots and imbeciles are shown round. The parents of aments hope for some miraculous cure. Medical opinion is insufficiently trained. The schools give little individual attention; mere examination-failures and real mental deficiency are not distinguished. The school causes so much mere memory work that aments, who often possess remarkable memories, may prove successful in the course, though they have actually derived no educational profit. For these reasons detection and treatment of mental deficiency is, in India, extremely difficult. Facilities for treatment of such cases are needed. The social conscience needs to be roused against the marriage of mental defectives, especially in the case of females.

G. C. CHATTERJEE.

There are varying grades of intelligence, ranging from idiocy to genius. Present school courses are intended for the average. The mentally defective child is not merely deficient in intelligence but in personality and character also. The defective child who possesses some elements of character and personality is amenable to training; e.g., the work of Dr. Bernstein. The immediately important problem in India is to detect the slightly subnormal who in ordinary schools impede the progress of the normal child, and to make provision for them. There is at present no machinery for coping with the problem. A central agency is needed to co-ordinate work in educational and psychological research.

A. K. DUTT.

Only one per cent. of the population in London is taken care of by the special schools. The dullards and backwards are a far larger proportion. About one third of the school population is 'Subnormal': there is a great wastage in this group. In India 6 % of the population attend school. Only 20 % of the primary school population obtain literacy, *viz.*, 20 % of 6 % of the population obtain literacy. Our schools are run on the assumption that all children are precisely normal, and no allowance is made for variations from the normal. Deferentiation of studies in the schools is required. Until provision has been made for this large 'dullard' group it is premature to concern ourselves with the small group of Mental Defectives and Feeble-minded. The Association Co-efficient between Illiteracy and Crime is ·7, whereas between mental Deficiency and Crime it is only ·3. Thus it is rather Illiteracy than the Mental Deficiency that conduces to crime.

HARIDAS BHATTACHARYYA.

This is rather a problem of the future than of the present. Amentia becomes a problem when conditions of society become so complex that

only the more mentally developed can adjust themselves to it. Under present conditions in the village the Mental Defective is not to look after the cattle, to carry water. As India becomes less agricultural and more industrial the problem of amential will become more acute. It is the task of educator to keep pace with the change and adjust youth to these rapidly changing conditions. At present the youth of India is not being so adjusted; neurasthenia is on the increase, and the outlook for the future of the youth of Bengal is ominous. Morals are becoming lax: venereal disease is in the increase. Middle class unemployment is a symptom of this maladjustment.

Col. O. Berkley Hill.

It is important to distinguish mental from emotional defect, also the congenital from acquired deficiency, which latter may yield to endocrine treatment. Is mental Defect a variant, or a defect of germ plasm? If a variant, sterilization would have to take place over a number of generations. Mental Deficients tend to die out of themselves. Probably natural selection will deal with the problem without sterilization. A real attempt is being made in Madras to deal with problems of mental deficiency: three of the large hospitals are providing out-patient clinics, and wards for early cases of mental disorder and an institution for mentally defective children. In regard to the educational problem of the backward, it is economically unsound to make the father of the clever child pay for the education of the stupid. Classification and special treatment is very necessary. The question of the social adjustment of the youth of India is a very serious question. The rapid changes of the present must inevitably entail a large amount of unhappiness: it is the task of the psychologist and educationist to minimize it.

Girindra Sekhar Bose.

The problem of the backward child is not strictly within the terms of the subject, which is "Mental Deficiency." So also is the socially maladjusted normal. There is no doubt, from the speaker's records, that deficiency is often hereditary, and is often closely associated with epilepsy: on the other hand there are striking exceptions, where genius and imbecility occur in the same family. Sterilization is a question which must be approached with caution.

S. C. Sinha.

Emphasised the need of exact statistics of the proportion of deficiency in Bengal.

D. K. Chakrabarty.

Questioned whether deficiency was subject to the Mendelian law.

Michael P. West.

Owing to the absence of any effective system of primary education in Bengal the High Schools contain a random sampling of the population ranging from mental deficiency upwards. Most of the educational difficulties of this Province are due to the fact that we are attempting to give a higher education in a foreign language, suited only to the supernormal, to the merely normal and subnormal.

Resolution.

Prof. Chatterjee.—Moved a resolution recommending the Central Government to organize a research for the study of mental defect.

Second Symposium.

31. The Relations of Psychiatry to Psychology.

LT.-COL. O. BERKLEY HILL, I.M.S.

INTRODUCTION.

In my contribution to this symposium, I propose to confine myself to a consideration of the relations between psychology and one of the branches of psychiatry, namely, psychotherapy. To make my point of view intelligible, I must first define what I understand by psychotherapy. The importance of making a clear definition of psychotherapy, becomes still more evident when we realise that one school of psychotherapeutists regards psychotherapy as a method of treating disorders of the mind, while another school of psychotherapeutists regard the mind as not the object but the means of treatment. Grasset puts the matter very well when he writes: "Electrotherapy and hydrotherapy are not treatments of electricity or water, but treatments by electricity and water; in like manner, psychotherapy is not treatment of the mind but by the mind." I agree with Janet that to hold this view of psychotherapy is to restrict psychotherapeutic procedures to the application of certain special psychological phenomena, for which there is no justification. When we speak of psychotherapeutics, we must include within its scope all the psychological phenomena which can exercise a valuable influence. Janet defines psychotherapy as follows: "Psychotherapy is a totality of therapeutic procedures of all kinds, both physical and moral, applicable alike to bodily and mental disorders, procedures determined by the consideration of psychological phenomena which have previously been studied, and above all by the consideration of the laws which regulate the development of these psychological phenomena. In a word, psychotherapy is an application of psychological science to the treatment of disease." Now a therapeutic method to be of any value should be founded upon definite laws which are able to indicate the treatment suitable for this or that disorder. That psychotherapy is not founded on laws capable of making such indications is a demonstration of the inadequacy of our knowledge of psychology. Indeed, we may go so far as to say that it is entirely due to psychotherapy that we have discovered the existence of huge gaps in our science of psychology. Our ignorance of psychology is never more evident that when we turn to it for help in the diagnosis or treatment of mental disorders. Although it is possible to trace the influence of medicine on the theories and practical applications of psychology, through all the ages, psychology, until quite recently, has shewed little concern with the realities upon which it should act. In these circumstances, it would perhaps be wise to draw the simple conclusion that an attempt to make use of psychotherapeutics is premature, and to decide that we shall reconsider the matter a century hence. But suffering humanity cannot wait. Treatment must be applied to disease however incomplete are the laws upon which that treatment is based. Hence psychotherapy, in its beginnings, had to depend for guidance upon observations that were almost devoid of precision. The numerous so-called mental-healers as well as Doctors, tried to relieve any and every kind of physical and mental disorder with the aid of psychological phenomena about which only very little was known. As our knowledge of psychology became somewhat more precise, psychotherapy became correspondingly more scientific. The study of tenden-

cies, of psychic reflexes, and of the various psychological automatisms, made it possible to turn to account the different forms of suggestion, which aim at inducing an automatic functioning of this or that tendency. Ideas concerning fatigue and depression which follow excessive mental activity, led to the adoption of a therapeutic method designed to economise the energy of the mind. This method assumed different forms. In one, namely, psychoanalysis, the aim is to economise expenditure by abolishing all that which is connected with certain unhappy memories or certain undesirable tendencies. In another, namely that associated with the name of Weir Mitchell, the attempt to restrict expenditure took the form of a suppression of movements and actions; or of the isolation of the patient and the restriction of social life. Then the study of mentally-defective children has added to our knowledge of the psychology of the so-called normal child and, in addition, given rise to various methods of treatment by what has come to be known as "re-education". Finally, entering into a far more hypothetical field, psychotherapeutists have endeavoured to explain the changes, characteristics of awakening, effort, and attention, and to understand the nature of the immense increase of energy which appears to result from confidence, faith and enthusiasm—these researches leading to the therapeutic methods of aesthesiogenism and excitation. We may pause for an instant to enquire if this advance of psychological knowledge made psychotherapeutic methods more practical? We have, alas, to answer this question in the negative. Every alienist knows that a very large number of his patients pass into incurable dementia or remain mentally disordered for an indefinite period. A notable French psychiatrist (Ballet) has even gone so far as to write: "I am very doubtful whether psychotherapy, of whatever kind, or whatever methods be employed, has ever curtailed by a single hour the duration of the most trifling periodic attack, any more than it has curtailed the duration of a very grave attack of circular insanity." With this extreme pessimism as to the value of psychotherapy, only a few will find it possible to agree. For my part, I am convinced that psychotherapy in the widest sense of the term has unquestionably done good service in a number of cases. But this is not all that we may place to the credit of psychotherapy. As I have already observed, psychotherapy has rendered a great service in forcibly compelling psychology to attend to its own subject matter. Janet writes: "It is the necessities of therapeutic application which are today compelling psychology to devote its attention to its own proper topic, which is the description and the scientific explanation of human behaviour. Accurate study of the details of behaviour, of the need to love and be loved, of jealousy, of timidity, etc., which in former days were regarded as minor accessories, as literary adjuncts of true psychology, have now come to be regarded as the very core of a truly practical and useful psychology. The searching out of the laws that regulate changes of temper, degrees of activity, and forms of emotion, must not be left to the novelists, but must be the main concern of psychologists, for the whole of our psychotherapy must be based upon a knowledge of these laws. Medical practitioners have turned to psychology and have demanded of this science a service which it was totally unprepared to render. Psychology has not proved equal to the occasion, and the failure of the science has thrown discredit upon psychotherapy itself. But this very failure has necessitated entirely new psychological studies to the end that the science of psychology is now in the process of being regenerated.

Girindra Sekhar Bose.

Psychiatry as a separate branch of medicine is comparatively of recent origin and the psychological outlook in psychiatry is still more

recent. The psychiatrists looked upon the body as the more important factor, and the mind was studied merely as a part of a symptom-complex which helped one to understand the nature of the bodily injury. There was no necessity to study the mind as an entity apart from the body. The psychiatrists treated mental diseases solely by medicines. It was, of course, understood that the patients' mind should be favourably influenced, but beyond the effort of placing the patient amidst cheerful surroundings, nothing definite was attempted in this direction. Mental treatment formed a part of the general hygiene. Efforts were made to study the organic changes occurring in a mental patient, and, whenever such a lesion was dicovered, it was thought to be the causative factor. Treatment consisted in correcting such defects. If we take the case of *dementia praecox* as an example we find that in an advanced case, after death, autopsy shows that changes occur in the thyroid, the adrenal bodies, the testes and sometimes in the brain cells. On the assumption that one or all of these organs were the primary source of mischief treatment was attempted by specific glandular therapy. The results were extremely disappointing. I do not deny the value of such methods of investigation, but in psychiatry they have not been very helpful as yet. In functional nervous disorders these attempts proved absolutely futile. The eminently successful treatment of the mental state of a cretin by the administration of thyroid and a few other cases of this type raised the hope that other kinds of mental affection also would be amenable to this form of treatment. Hence the persistent effort in this direction. Endocrinology has fostered this hope to a very great extent but in the practical sphere unfortunately the scope of such a therapy is as yet very limited, notwithstanding the claims of enthusiasts. That day is yet to come when we could cure jealousy for instance or an obsessional idea by a dose of a particular gland

The mental outlook was introduced into psychiatry by the use of hypnotism in practical therapeutics. It was found that profound organic changes could be brought about during hypnosis. The influence of the mind on the body was no longer a vague platitude to be asserted as a general proposition. It was demonstrated before one's eyes. There could be no denying the facts. Psychotherapeutics received a great support from the work of the hypnotists and numerous mental forms of treatment were evolved. There was the treatment by persuasion by Dubois, there was the emotional appeal by Djerine, there was the treatment by suggestion in the waking or the hypnoid state. Treatment by diversion and occupational therapy came into the field. Faith cures, Christian science and auto-suggestion caught the popular imagination. This was psycho-therapy with a vengeance. Each of these systems independently developed its special psychology and its special theory of the mind. But the work was more or less empirical, and no real effort was made to understand the deep workings of the psychic apparatus. When psycho-analysis came into the field the ground was already well laid out for psycho-therapy. It lies to the credit of psycho-analysis that, although it was primarily intended as a therapeutic measure, it soon found out the necessity of understanding the intricate workings of the mental apparatus. Its aim was a radical cure of the mental malady it undertook to treat, and the radical cure could not be effected without knowing the details of the mental mechanism which was out of gear. The dynamic conception of mental life was realised, and a true psychological outlook came into psychiatry. The psychology which came into being as the result of a study of abnormal mental cases remained out of touch with academic psychology. Psychiatry thus developed a new psychology all its own.

The relationship between Psychology and Psychiatry is ultimately the one existing between normal and abnormal psychology. In nature there is never a sharp line of demarcation between the normal and the abnormal. The distinction is more or less an arbitrary one necessitated by the demands of society. It is only in the biological group of sciences that we

postulate such a difference. In Physics, Chemistry or Methematics, for instance, there is no question of any distinction between the normal and the abnormal. Since the distinction is an arbitrary one, one would expect normal and abnormal psychology to grow along common lines with a common foundation. But, curiously enough, the normal and abnormal branches of psychology have developed as if they were different sciences altogether. A large number of Psychiatrists have kept themselves aloof from the teachings of normal Psychology which they find to be unnecessary in understanding their cases. The academic psychologists, on the other hand, are not familiar with the interpretations of mental life as enunciated by psycho-pathologists. Even the terminology of abnormal psychology is something foreign to them. The gulf that separates normal and abnormal psychology is much wider than that separating Physiology and Pathology. This unfortunate state of things is due to the fact that abnormal psychology owes its development, not to the scientific curiosity which is responsible for the growth of Psychology, but to the social urge which drives a practical physician to the study of medicine and therapeutics. It is high time, therefore, that some sort of attempt was made to bring about a co-relation between the findings of normal and abnormal Psychology. The holding of the symposium, therefore, is none too premature. Indeed it has been overdue.

There are signs abroad that academic psychologists are now getting themselves interested more and more in abnormal psychology, and no textbook of the present-day fails to take notice of the findings of the psychopathologists though such reference is very meagre. If we take a bird's-eye view of the history of development of Psychology, we come across certain definite trends dominating the science at different periods. At the outset Psychology was a handmaid to Philosophy and much of its teachings was influenced by philosophical dogmas Then came Fechner with his Psycho-physics, and the whole subject of Psychology was given a definite experimental trend. Fechner's Psycho-physics was, however, short-lived. The extraordinary advance of Physiology made it possible for certain psychological problems to be studied from the physiological standpoint. Physiological Psychology began to rule the day and in recent times the study of Endocrinology gave it a fresh impetus. The Behaviourists then came into the field, and they are still going strong. The last war with its numerous cases of shell-shock has been primarily responsible for bringing the teachings of abnormal psychology to the forefront. If one accepts the definition that psychology is a science of the mental states, then one would not be deemed rash in saying that, of all these contending schools, the one of abnormal psychology is likely to be the greatest in the matter of contribution to normal psychology. Abnormal conditions do not create any new state; they simply impair or exaggerate a normal trait or develop a latent one. A mental characteristic which has assumed an exaggerated form is easier to observe and is more fruitful of results in investigation.

Abnormal psychology has introduced quite a new life into psychological studies. Academic psychology has been, up till now, more or less barren in its practical applications. Although professing to study the mental life of individuals it has hitherto succeeded only in analysing and investigating isolated components of human experience. It has been more or less static in its outlook. That the whole mind is a dynamic reality was never properly appreciated by the academic psychologists. It remained for the psychiatrists to point out and emphasise the dynamic aspect of mental life. Academic psychology has contributed very little towards the solution of problems of Psychiatry. Apart from the mental tests and the experimental investigation of Kraepelin in mental cases, I do not know of any other sphere where the findings of academic psychologists have been utilized by mental pathologists. The measurement of memory, attention, fatigability, *etc.* in mental cases has thrown very little light on the solution of problems

of mental disease. On the other hand abnormal psychology has thrown a flood of light on some of the most important problems of normal psychology. The theory of the unconscious, which is a contribution of the psychiatrists is bound to be of immense help in understanding many of the problems of normal psychology. The problems of association of ideas, of memory, of dreams *etc.* have all been illuminated by the study of abnormal-processes. The higher mental states, such as wish, thought *etc.* were very imperfectly studied from the standpoints of normal psychology. A great deal of new knowledge has been acquired in these spheres as a result of investigation of abnormal mental states. The dynamic conception in abnormal psychology has been instrumental in bringing to light certain psychical mechanisms which explain in quite a satisfactory manner some of the problems of normal psychology, such as lapses of memory, mental peculiarities, particular trends of association *etc.* The great defect of academic psychology and of some of the modern trends such as Behaviourism, has been the objective outlook. So long as our attention is directed towards actions and outside manifestations of normal mental life, we are apt to miss the inner workings of the mind which alone really form the subject matter of Psychology. The great value of introspection in the working out of psychological problems has not yet been truly appreciated.

In the domain of Psychiatry the study of maniacal and allied states has not been fruitful from the psychological standpoint, the reason being that there is considerable difficulty in getting at the mental states of the subject. In such cases there is no dearth of opportunity of studying the behaviour of these patients. The greatest amount of knowledge regarding the working of the mind has come from a study of the border line cases, mainly the psycho-neuroses where subjective disturbances form the most important symptom These patients are quite capable of reporting their introspective experience, and a critical study of psycho-neuroses has yielded very important findings which are applicable in the domain of normal psychology also. When we come to co-relate the findings of normal and abnomal psychology we shall find that many of the chapters in current text-books will have to be re-written. The great part the mental attitude plays in determining the nature of perception, association of ideas and flow of memory and in the creation of illusions, etc., has only been dimly realised by the students of normal psychology. The present Gestalt school has done a service by pointing out the importance of such attitude. The vast importance of the conscious and unconscious wish in creating these attitudes has been emphasised by the workers of abnormal psychology. The problem of repression has as yet received scant attention from the present-day teachers of Psychology. They have yet to realise that this is an important key to the solution of different character types. The nature of the ego and its workings can only be studied successfully through the path opened up by abnormal psychology. A fusion of normal and abnormal psychology is bound to result in an extraordinary advance of the solution of problems of normal psychology.

H. D. Bhattacharyya.

The failure of academic psychology to understand abnormal minds is due not to incapacity but to accident. The philosophers who were also psychologists of their times were not to be thought of as capable of taking charge of abnormal minds. The educationists who took up the work of psychologising had their hands full with providing for the needs of normal boys and studying their minds in certain periods of the day. The parents who had opportunities were not experts. So a threefold neglect brought about an indifference towards the misfits.

The doctor alone was trusted to treat the body, and, when he felt that something more than the body was involved, he passed on to the study

of mind to get light on the symptoms. Even now lay analysis would not be tolerated in most communities. No wonder therefore that it was left to the medical profession to explore the abnormal mind and to develop a new technique sufficient for its own needs. But the academic psychologist had to take note of all the aspects of personality and as he was not trusted with abnormal minds, his findings tallied most with the processes of normal minds.

When the psychologist came to see that body was of significance in the study of mind the party he had to consider first were the biologists whose doctrine of evolution made a study of reflexes and instincts unavoidable. Proper understanding of these in relation of mind is still to come; and, when the psychologist is still engaged in the task, the medical profession has brought out a mass of facts to which the academic psychologist is asked to turn his attention. A few of them are finding obscure hints of such studies in the works of a few academic psychologists. The strength of these lay however in analysing individual mental states of an isolated subject and not in studying the social reactions of a personality. But that led to a certain amount of abstractness in their treatment of minds and to a study only of the personal aspects of mental functioning. Thus while the factor of a cognition or will would be stated, it was not undestood why such and such a wish or cognition should arise. But, as in the study of the human body, there is need of both an anatomist and a psychologist, so also there is need of an academic psychologist and a psychiatrist. The psychoanalyst has taken for granted the discoveries of the academic psychologist in the domain of association, memory, etc., and has taken them as a matter of course, for it is on the basis of psychology that psychoanalysis has raised its structure.

Discussion.

Dr. N. N. Sengupta said that the greatest difficulty in determining the relation between the two fields of psychology and psychiatry lay in the absence of a recognised definition of psychology. To the speaker, the subject matter of psychology was *a pattern* of mental states and behaviour. The task of psychology was to discover the determinants which regulate the character of the psycho-physical pattern. Four such determinants seemed operative: (1) Past history of mind, conscious and unconscious; (2) Bodily constitution; (3) Social environment; (4) Physical environment. Thus, we might understand the nature of mental life from the point of view of abnormal psychology, physiological psychology, social psychology and experimental psychology. Each of these was a special method. There was no conflict between them.

Dr. B. C. Ghose said that, as in Endocrinology, so in Psychology. the normal has been studied through the abnormals, but the methods of psychoanalysis were essentially the same as the introspective methods of the classical psychologist.

Mr. R. C. Haldar emphasised the need of co-ordinating technical terms, It was the psychoanalyst who took up the study of the functional aspect of mind: it was very necessary that the psychologist should turn more to the functional aspect.

Dr. S. L. Sarkar drew attention to the value of the psychoanalyst's contribution to the study of the growth of specific functions in the mind, *e.g.*, of the sex impulses.

Dr. G. S. Bose said that he had not wished to suggest in his opening speech that he had any quarrel with the academic psychologist. Dr. Sengupta had admirably shown the relationship of the psychiatrist and the psychologist. What he did wish to suggest was that the greatest future contributions seemed likely to come from the study of the abnormal.

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RULES.

INDIAN SCIENCE CONGRESS.

I. The administrative work of the Congress shall be carried on by an Executive Committee, who shall submit such questions as they think desirable to a General Committee at its annual meeting or at a special meeting of which satisfactory notice shall be given.

II. The General Commitee shall consist of all full members (*Vide Rule XI ;*) who have attended three meetings (including that actually taking place at any time) and those members who have held office in the Congress. This Committee shall meet at least once at each Congress, usually in the middle of the meeting.

III. The Executive Committee shall consist of the President, the retiring President, the two General Secretaries, the Treasurer of the Asiatic Society of Bengal, the General Secretary of the Asiatic Society of Bengal and three members elected by the General Committee at its Annual General Meeting. The Executive Committee shall have full powers to transact all business in case of need, notwithstanding any limitations herein laid down.

IV. The Council shall consist of the members of Executive Committee, of the Past Presidents resident in India and five other members appointed by the General Committee at its annual meeting.

The Council shall be consulted on matters of general scientific importance and policy.

V. The nomination of the President shall be made by the Executive Committee and submitted for confirmation to the General Committee.

VI. The Sectional Presidents shall be appointed by the Executive Committee.

(*Experience shows that there is not time for any other arrangement to work satisfactorily.*)

VII. The two General Secretaries shall be nominated by the Executive Committee and submitted to the General Committee for confirmation.

[1] Each General Secretary shall hold office for five years from the date of his appointment, but shall be eligible for reappointment.

VIII. As long as the present relationship with the Asiatic Society of Bengal continues, the General Secretary and the Treasurer of that Society shall be members of the Executive Committee.

IX. The Local Secretary (or Secretaries) and the Local Committee for any meeting of the Congress shall be appointed by the Executive Committee.

X. The Local Secretary (or Secretaries) and the Local Committee shall assist in making arrangements for the reception and entertainment of the visitors and for the distribution of letters at the meeting.

XI. There shall be three classes of members :—

(i) *Full members :* Annual subscription *Rupees ten.*
(ii) *Associate members :* Annual subscription *Rupees five.*
(iii) *Student members :* Annual subscription *Rupees two.*

(Student members must be definitely certified by the principal of their College as *bona fide* students.)

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[1] Added at the Calcutta Meeting, 1928.

Only full members have the right of communicating papers to the Congress and they receive free of charge all publications. Associate and Student members have the right of reading papers before the Congress provided they have been communicated by a Full member.

[1] XII. The following procedure is to be adopted for making any additions or alterations in the above rules:—

(*a*) Proposals for additions to and alterations in the existing rules are to be sent to the General Secretary at least two months before the meeting of the General Committee at which they are to be moved. The General Secretary, on receipt of such proposals, shall circulate them to all members of the General Committee who paid their annual subscription at the last session of the Congress.

(*b*) Any amendments to the proposals shall be sent to the General Secretary at least a fortnight before the meeting of the General Committee.

[1] XIII. The proposals with amendments shall be brought up before the meeting of the General Committee (with remarks of the Executive Committee, if any) and declared carried, if accepted by a two-thirds majority of those present at the meeting.

SECTIONAL COMMITTEES.

XIV. (*a*) The Sectional Committees shall consist of not more than three members who shall be :—

(1) The President of the Section (convenor).
(2) The retiring President of the Section.
(3) One member elected by the General Committee at its Annual General Meeting.

(*b*) The Sectional Committee shall arrange and referee all papers to be read before the Section.

(*c*) The Sectional Committee shall have power to fill vacancies during the year of their appointment.

(*d*) The Sectional Committee shall nominate annually a President for the section for the consideration of the Executive Committee.

PAPERS.

[2] XV. (*a*) An abstract of any paper to be read at the Indian Science Congress must be submitted to the General Secretary or the President of the Section concerned not later than the 15th of October. [This will enable abstracts to be printed and circulated to members before leaving their Stations to attend the Congress.]

(*b*) All papers which are to be read must be referreed by the Sectional Committee or by some person appointed by them, the decision to be final and all reports confidential. In deciding whether a paper should be read the Sectional Committees will take into consideration the question whether the paper has been previously published.

(*c*) Each paper must be accompanied by an abstract and if the paper be of great length, it should be summarised.

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[1] Added at the Bangalore Meeting, 1924.
[2] Amended at the Benares Meeting, 1925.

OFFICERS OF THE FIRST FOURTEEN MEETINGS OF THE INDIAN SCIENCE CONGRESS.

(1914–1927.)

PATRONS.

1914. H.E. The Rt. Hon. Thomas David Baron Carmichael of Skirling, G.C.I.E., K.C.M.G., Governor of Bengal.
1915. H.E. The Rt. Hon. Baron Pentland of Lyth, G.C.I.E., Governor of Madras.
1916. His Honour Sir James Scorgie Meston, K.C.S.I., Lieutenant-Governor of the United Provinces.
1917. H.H. The Maharajah of Mysore, G.C.S.I.
1918. H.E. Sir Michael O'Dwyer, G.C.I.E., K.C.S.I., Lieutenant-Governor of the Punjab.
1919. H.E. Sir George Lloyd, G.C.I.E., D.S.O., Governor of Bombay.
1920. The Hon'ble Sir Benjamin Robertson, K.C.S.I., K.C.M.G., C.I.E., LL.D., I.C.S., Chief Commissioner, Central Provinces.
1921. H.E. The Rt. Hon. The Earl of Ronaldshay, G.C.I.E., Governor of Bengal.
1922. H.E. Lord Willingdon, G.C.S.I., G.C.I.E., G.B.E., Governor of Madras.
1923. H.E. Sir William Marris, K.C.S.I., K.C.I.E., Governor of the United Provinces.
1924. H.H. The Maharajah of Mysore, G.C.S.I., G.B.E.
1925. H.H. The Maharajah of Benares, G.C.S.I., G.C.I.E.
1926. H.E. The Rt. Hon. Sir Leslie Wilson, P.C., G.C.I.E., C.M.G., D.S.O., Governor of Bombay.
1927. H.E. Sir William Malcolm Hailey, B.A., K.C.S.I., C.I.E., I.C.S., Governor of the Punjab.

CONGRESS PRESIDENTS.

1914. The Hon. Justice Sir Asutosh Mukherjee, Kt., C.S.I., M.A., D.L., F.A.S.B.
1915. The Hon. Surgeon-General W. B. Bannermann, C.S.I., M.D., D.Sc., I.M.S.
1916. Colonel Sir Sydney Burrard, K.C.S.I., F.A.S.B., F.R.S., R.E.
1917. Sir Alfred Gibbs Bourne, K.C.I.E., D.Sc., F.R.S.
1918. Dr. Gilbert T. Walker, C.S.I., M.A., Sc.D., F.R.S.
1919. Lt.-Colonel Sir Leonard Rogers, Kt., C.I.E., M.D., B.S., F.R.C.P., F.R.C.S., F.A.S.B., F.R.S., I.M.S.
1920. Sir Prafulla Chandra Ray, Kt., C.I.E., Ph.D., D.Sc., F.A.S.B.
1921. Sir Rajendra Nath Mookerjee, K.C.I.E., K.C.V.O.
1922. C. S. Middlemiss, Esq., C.I.E., B.A., F.A.S.B., F.R.S.
1923. Sir M. Vishweshwarayya, K.C.I.E., M. Inst. C.E., D.Sc.
1924. Dr. N. Annandale, C.I.E., D.Sc., F.A.S.B., F.R.S.
1925. Dr. M. O. Forster, F.R.S.
1926. A. Howard, Esq., C.I.E., M.A.
1927. Sir J. C. Bose, Kt., C.S.I., C.I.E., D.Sc., F.R.S.

COUNCIL.*

1923.

Sir Asutosh Mukherjee.
Sir Gilbert T. Walker.
Sir P C. Ray, Kt.
Sir R. N. Mookerjee.
Sir M. Vishweshwarayya.
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Prof. P. Sampathiengar.
Dr. K. N. Bahl.
Dr. N. Kunjan Pillay.
Dr. Nilratan Dhar.

1924.

Sir Asutosh Mukherjee (†7th May, 1924).
Sir Gilbert T. Walker.
Sir P. C. Ray, Kt.
Sir R. N. Mookerjee.
Sir M. Vishweshwarayya.
Dr. N. Annandale (10th April, 1924).
Dr. J. L. Simonsen.
Prof. C. V. Raman.
Dr S. P. Agharkar.
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Dr. K. N. Bahl.
Dr. N. Kunjan Pillay.
Dr. Nilratan Dhar.
Dr. J. N. Mukherjee.

1925.

Sir P. C. Ray, Kt.
Sir R. N. Mookerjee.
Sir M. Vishweshwarayya.
Dr. M. O Forster.
Dr. Baini Prashad.
Dr. J. L. Simonsen.
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Dr. S. L. Hora.
Dr. E. R. Watson.
Dr. D. M. Bose
Johan van Manen, Esq.
Prof. H. C. Das-Gupta.
Prof. G. Matthai.
Prof. S. L. Ajrekar.
A. Howard, Esq.
Dr. B. Sahni.

1926.

A. Howard, Esq.
Dr. M. O. Forster.
Prof. B. Sahni.

---

* The Council was established by a resolution of the General Committee in 1922 at Madras and was first constituted in 1923.

Dr. S. L. Hora.
Johan van Manen, Esq.
Prof. Roland V. Norris.
Prof. S. P. Agharkar.
Sir P. C. Ray, Kt.
Sir R. N. Mookerjee.
Sir M. Vishweshwarayya.
Prof. S. L. Ajrekar.
Prof. D. M. Bose.
Prof. H. C. Das-Gupta.
Dr. E. R. Watson.
Sir J. C. Bose, Kt.
Prof. C. V. Raman.
Major R. B. Seymour Sewell.
Prof. G. Matthai.

1927.

Dr. J. L. Simonsen.
Sir J. C. Bose, Kt.
Prof. S. P. Agharkar.
Prof. Roland V. Norris.
Dr. Baini Prashad.
Johan van Manen, Esq
Prof. S. R. Kashyap.
Prof. J. C. Ghosh.
Prof. H. C. Das-Gupta.
Sir P. C. Ray, Kt.
Sir R. N. Mookerjee.
Sir M. Visweshwarayya.
Dr. M. O. Forster.
A. Howard, Esq.
Prof. S. L. Ajrekar.
Prof. D. M. Bose.
Prof. G. Matthai.
Diwan Anand Kumar, Esq.

EXECUTIVE COMMITTEE.

1916.

Sir Alfred Bourne.
Sir Sydney Burrard.
Dr. J. L. Simonsen.
Prof. P. S. MacMahon.
R. D. Mehta, Esq. (Treasurer, A.S.B.).
Dr. F. H. Gravely (Gen. Sec., A.S.B.).

1917.

Dr. Gilbert T. Walker.
Sir Alfred Bourne.
Dr. J. L. Simonsen.
Prof. P. S. MacMahon. (In England.)
R. D. Mehta, Esq. (Treasurer, A.S.B.).
Dr. F. H. Gravely (Gen. Sec., A.S.B.).

1918.

Sir Leonard Rogers.
Dr. Gilbert T. Walker.
Dr. J. L. Simonsen.
Prof. P. S. MacMahon. (In England.)
R. D. Mehta, Esq. (Treasurer, A.S.B.).

Dr. F. H. Gravely (Gen. Sec., A.S.B., up to end of February).
Dr. W. A. K. Christie (Gen. Sec., A.S.B., from March).

1919.

Sir P. C. Ray, Kt.
Sir Leonard Rogers.
Dr. J. L. Simonsen.
Prof. P. S. MacMahon.
R. D. Mehta, Esq. (Treasurer, A.S.B.).
Dr. W. A. K. Christie (Gen. Sec., A.S.B.).

1920.

Sir R. N. Mookerjee.
Sir P. C. Ray, Kt.
Dr. J. L. Simonsen.
Prof. P. S. MacMahon.
Oswald Martin, Esq. (Treasurer, A.S.B.).
Dr. W. A. K. Christie (Gen. Sec., A.S.B., up to May).
A. H. Harley, Esq. (Gen. Sec., A.S.B., from May).

1921.

Sir Thomas Holland (up to ?).
C. S. Middlemiss, Esq. (from ?).
Sir R. N. Mookerjee.
Dr. J. L. Simonsen.
Prof. P. S. MacMahon.
Oswald Martin, Esq. (Treasurer, A.S.B., up to November).
A. H. Harley, Esq. (Treasurer, A.S.B., from November).
Dr. W. A. K. Christie (Gen. Sec., A.S.B.).

1922.

Lt.-Col. A. T. Gage (up to ?).
Sir M. Visweshwarayya (from ?).
C. S. Middlemiss, Esq.
Dr. J. L. Simonsen.
Dr. C. V. Raman.
W. R. C. Brierley, Esq. (Treasurer, A.S.B.).
Dr. W. A. K. Christie (Gen. Sec., A.S.B., up to March).
Dr. S. W. Kemp (,, ,, up to July).
Dr. E. P. Harrison (,, ,, up to 31st August).
A. H. Harley, Esq. (,, ,, up to end of September).
Dr. S. W. Kemp (,, ,, from October).

1923.

Sir Asutosh Mukherjee. (Resigned in November.)
Dr. N. Annandale (from November).
Sir M. Visweshwarayya.
Dr. J. L. Simonsen.
Dr. C. V Raman (Gen. Sec., I.Sc.C., and Treasurer, A.S.B.).
Dr. S. W. Kemp (Gen. Sec., A.S.B., up to February).
Johan van Manen, Esq., (Gen. Sec., A.S.B., from February).

1924.

Dr. M. O. Forster.
Dr. N. Annandale (†10th April).
Dr. J. L. Simonsen. (In England from April.)

{ Dr. C. V. Raman (up to May).
{ Dr. S. P. Agharkar (from May).
Dr. N. R. Dhar.
Dr. Baini Prashad (Treasurer, A.S.B.).
Johan van Manen, Esq. (Gen. Sec., A.S.B.).

1925.

A. Howard, Esq.
Dr. M. O. Forster.
Dr. J. L. Simonsen.
Dr. S. P. Agharkar.
Dr. B. Sahni.
{ Dr. Baini Prashad (Treasurer, A.S.B., up to 3rd August).
{ Dr. S. L. Hora (,, ,, from 3rd August).
Johan van Manen, Esq. (Gen. Sec., A.S.B.).

1926.

A. Howard, Esq.
Sir J. C. Bose, Kt.
Prof. C. V. Raman.
Prof. B. Sahni.
Major R. B. Seymour Sewell.
Dr. S. L. Hora (Treasurer, A.S.B.).
Johan van Manen, Esq. (Gen. Sec., A.S.B.).
Prof. S. P. Agharkar.
Prof. Roland V. Norris.

1927.

Dr. J. L. Simonsen.
Sir J. C. Bose, Kt.
Prof. S. P. Agharkar.
Prof. Roland V. Norris.
Dr. Baini Prashad (Treasurer, A.S.B.).
Johan van Manen, Esq. (Gen. Sec., A.S.B.).
Prof. S. R. Kashyap.
Prof. J. C. Ghosh.
Prof. H. C. Das-Gupta.

(*N.B.*—The General Secretary and Treasurer of the Asiatic Society of Bengal are *ex-officio* members of the Executive Committee of the Congress.)

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1914. D. Hooper, Esq.
1915. Prof. J. L. Simonsen.
Prof. P. S. MacMahon.
1916. Prof. J. L. Simonsen.
Prof. P. S. MacMahon.
1917. Prof. J. L. Simonsen.
Prof. P. S. MacMahon.
1918. Prof. J. L. Simonsen.
Prof. P. S. MacMahon.
1919. Prof. J. L. Simonsen.
Prof. P. S. MacMahon.
1920. Prof. J. L. Simonsen.
Prof. P. S. MacMahon.
1921. Prof. J. L. Simonsen.
{ Prof. P. S. MacMahon (up to April).
{ Dr. C. V. Raman (from April).

1922. Prof. J. L. Simonsen.
Prof. C. V. Raman.
1923. Prof. J. L. Simonsen.
Prof. C. V. Raman.
1924. Prof. J. L. Simonsen.
{ Prof. C. V. Raman (up to May).
{ Prof. S. P. Agharkar (from May).
1925. Prof. J. L. Simonsen.
Prof. S. P. Agharkar.
1926. Prof. S. P. Agharkar.
Prof. Roland V. Norris.
1927. Prof. S. P. Agharkar.
Prof. Roland V. Norris.

TREASURERS.

1914. D. Hooper, Esq.
1915. R. D. Mehta, Esq.
1916. R. D. Mehta, Esq.
1917. R. D. Mehta, Esq.
1918. R. D. Mehta, Esq.
1919. R. D. Mehta, Esq.
1920. Oswald Martin, Esq.
1921. { Oswald Martin, Esq. (up to 24th November).
A. H. Harley, Esq. (from 24th November).
1922. W. E. C. Brierley, Esq.
1923. Dr. C. V. Raman.
1924. { Dr. C. V. Raman (up to May).
Dr. Baini Prashad (from May).
1925. { Dr. Baini Prashad (up to 3rd August).
Dr. S. L. Hora (from 3rd August).
1926. Dr. S. L. Hora.
1927. { Dr. S. L. Hora (up to May).
Dr Baini Prashad (from May).

(*N.B.*—The Treasurer of the Asiatic Society of Bengal is *ex-officio* Treasurer of the Congress.)

SECTIONAL PRESIDENTS.

Agriculture.

1915. Dr. H. H. Mann, D.Sc.
1916. B. Coventry, Esq., C.I.E.
1917. J. MacKenna, Esq., C.I.E., M.A.
1918. Dr. L. C. Coleman, D.Sc.
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1926. G. S. Henderson, Esq., N.D.A., N.D.D.
1927 F. J. Warth, Esq., M.Sc.

Physics and Mathematics.

1914. V. H. Jackson, Esq., M.A.
1915. Dr. C. V. Raman, M.A.
1916. Dr. G. C. Simpson, C.B.E., F.A.S.B., F.R.S.
1917. The Rev. Dr. D. Mackichan, D.D., LL.D.

1918. Dr. Wali Mohammad, M.A.
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1920. Dr. N. A. F. Moos, F.R.S.E.
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1923. Dr. S. K. Banerjee, D.Sc.
1924. Prof. C. V. Raman, M.A., D.Sc., F.R.S.
1925. Prof. E. P. Metcalfe, B.Sc., F. Inst. P.
1926. Prof. Meghnad Saha, D.Sc., F. Inst. P.
1927. Prof. D. M. Bose, M.A., Ph.D.

Chemistry.

1914. P. S. MacMahon, Esq., M.Sc., B.Sc.
1915. Sir P. C. Ray, Kt., C.I.E., Ph.D., F.A.S.B
1916. Dr. J. J. Sudborough, F.I.C.
1917. Dr. J. L. Simonsen, F.I.C., F.A.S.B.
1918. Dr. G. J. Fowler, F.I.C.
1919. F. L. Usher, Esq., B.Sc.
1920. B. K. Singh, Esq., M.A., F.I.C.
1921. Dr. H. E. Watson, A.I.C.
1922. Dr. N. R. Dhar, F.I.C.
1923. Dr. A. N. Meldrum, D.Sc.
1924. Dr. E. R. Watson, M.A., D.Sc.
1925. Prof. J. C. Ghosh, D.Sc.
1926. Dr. B. B. Dey, D.Sc.
1927. Prof. H. K. Sen, M.A., D.I.C., D.Sc.

Zoology.

1914. Dr. J. R. Henderson, C.I.E.
1915. Dr. N. Annandale, F.A.S.B.
1916. Dr. W. N. F. Woodland.
1917. K. Ramunni Menon, Esq., M.A.
1918. Dr. B. L. Chaudhuri, B.A., F.R.S.E.
1919. F. M. Howlett, Esq., B.A., F.E.S.
1920. E. Vredenburg, Esq., A.R.S.M., A.P.C.S., F.A.S.B.
1921. Dr. F. H. Gravely, F.A.S.B.
1922. Dr. N. Annandale, F.A.S.B., C.M.Z.S.
1923. Prof. G. Matthai, M.A. (Cantab.), F.Z.S.
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1925. Dr. Baini Prashad, D.Sc.
1926. Dr. H. R. Mehra, M.Sc., Ph.D.
1927. Major R. B. S. Sewell, M.A., F.A.S.B., I.M.S.

Botany.

1914. C. C. Calder, Esq., B.A.
1915. Dr. C. A. Barber, C.I.E.
1916. A. Howard, Esq., C.I.E., M.A.
1917. Rao Bahadur K. Ranga Achari, M.A.
1918. R. S. Hole, Esq., C.I.E., F.C.H., F.L.S., F.E.S.
1919. S. R. Kashyap, Esq., M.Sc., B.A.
1920. Dr. W. Burns, D.Sc.
1921. Dr. B. Sahni, M.A., D.Sc.
1922. Dr. W. Dudgeon, Ph.D.
1923. Mrs. G. L. C. Howard, M.A.
1924. Prof. S. P. Agharkar, M.A., Ph.D., F.L.S.
1925. Prof. R. S. Inamdar, B.Ag., B.A.
1926. Rev. E. Blatter, S.J., Ph.D., F.L.S.
1927. Prof. M. A. Sampathkumaran, M.A., Ph.D.

Geology.

1914. Sir H. H. Hayden, Kt., C.S.I., C.I.E., D.Sc., F.A.S.B., F.R.S.
1915. Dr. W. F. Smeeth, M.A., A.R.S.M., F.G.S.
1917. C. S. Middlemiss, Esq., C.I.E., M.A., F.R.S.
1918. E. S. Pinfold, Esq., B.A., F.G.S.
1919. Dr. L. L. Fermor, O.B.E., A.R.S.M., F.A.S.B.
1920. P. Sampatiengar, Esq.
1921. D. N. Wadia, Esq., M.A., B.Sc.
1922. G. H. Tipper, Esq., M.A., F.A.S.B.
1923. Dr. E. H. Pascoe, M.A., D.Sc., F.G.S.
1924. Dr. W. F. Smeeth, M.A., A.R.S.M., F.G.S.
1925. Dr. G. E. Pilgrim, D.Sc., F.G.S.
1926. Prof. B. Sahni, M.A. (Cantab.), D.Sc. (Lond.), F.G.S.
1927. Prof. L. Dudley-Stamp, B.A., D.Sc.

(There was no Section of Geology in 1916.)

Medical Research.

1919. Lt.-Colonel W. Glen Liston, C.I.E., M.D., D.P.H., I.M.S.
1920. Lt.-Colonel W. F. Harvey, C.I.E., M.A., M.D., D.P.H., I.M.S.
1921. Lt.-Colonel J. W. D. Megaw, B.A., M.D., I.M.S.
1922. Major Cunningham, B.A., M.D., I.M.S.
1923. Major H. W. Acton, I.M.S.
1924. Lieut.-Col. S. R. Christophers, C.I.E., O.B.E., M.B., F.R.S., I.M.S.
1925. Lieut.-Col. F. P. Mackie, O.B.E., M.D., M.Sc., F.R.C.S., F.R.C.P., I.M.S.
1926. Dr. R. Row, M.D., D.Sc., (Lond.), L.M.S.
1927. Major R. N. Chopra, M.B., I.M.S.

Anthropology.

1914. Rao Bahadur L. K. Anantakrishna Ayyar, B.A., L.T.
1915. H. V. Nanjundayya, Esq., C.I.E., M.A.
1921. Rai Bahadur Sarat Chandra Roy, M.A., B.L., M.L.C.
1922. Rai Bahadur Hiralal, B.A., M.R.A.S.
1923. Shams-ul-Ulama Dr. Jivanji Jamshedji Modi, B.A., Ph.D., C.I.E.
1924. Rao Bahadur L. K. Ananthakrishna Ayyar, B.A., L.T., F.R.A.I.
1925. P. C. Mahalanobis, Esq., M.A., B.Sc.
1926. N. Subramaniya Iyer, Esq., M.A.
1927. J. H. Hutton, Esq., C.I.E., D.Sc., M.A., I.C.S.

(There were no separate meetings of the Section of Anthropology in intermediate years.)

Psychology.

1925. Dr. N. N. Sen-Gupta, M.A., Ph.D.
1926. Haridas Bhattacharya, Esq., M.A., B.L., P.R.S.
1927. Lt.-Col. Owen A. R. Berkeley-Hill, M.D., I.M.S.

CHAIRMEN OF THE LOCAL COMMITTEE.

1919. Sir Dorab J. Tata.
1920. The Hon'ble Mr. J. F. Dyer.
1921. Sir Asutosh Mukherjee, Kt.
1922. Hon. Sir Lionel Davidson, K.C.S.I., I.C.S.
1923. Hon. Mr. C. Y. Chintamani.
1924. Sir B. N. Seal, Kt.
1925. Pandit Madan Mohan Malavya.
1926. Sir C. H. Setalwad, Kt., LL.D.
1927. The Hon'ble Sir G. F. de Montmorency, M.A., K.C.I.E., K.C.V.O., C.B.E., I.C.S.

LOCAL SECRETARIES.

1914. D. Hooper, Esq.
1915. Dr. J. L. Simonsen.
1916. Prof. P. S. MacMahon.
1917. Prof. H. E. Watson.
1918. A. S. Hemmy, Esq.
R. S. Ruchi Ram Sahni, Esq., M.A.
1919. A. Normand, Esq.
. D. D. Kanga, Esq.
1920. M. Owen, Esq.
V. Bose, Esq.
1921. Dr. E. P. Harrison.
Dr. Hassan Suhrawardy.
1922. Capt. C. Newcomb, M.D., A.I.C., I.M.S.
Khan Sahib Md. Azizullah Sahib Bahadur, B.A., M.B., C.M.
1923. Prof. P. S. MacMahon.
Dr. Wali Muhammad.
1924. Prof. F. L. Usher.
S. A. Ramaswami Iyer, Esq.
1925. Prof. L. D. Coueslant, B.Sc., A.M.I.M.E.
Prof. K. K. Mathur, B.Sc., A.R.C.S.
1926. A. J. Turner, Esq., J.P., B.Sc., F.I.C.
Prof. G. R. Paranjape, M.Sc., I.E.S.
1927 Dr. S. S. Bhatnagar, D.Sc.
Dr. R. H. Whitehouse, D.Sc., I.E.S.

ACCOUNTS.

I.

Account of the Indian Science Congress for the year ending the 31st December, 1927.

EXPENDITURE.				RECEIPTS.			
Dr.	Rs.	A.	P.	Cr.	Rs.	A.	P.
By printing ..	273	4	0	To balance ..	7,924	14	2
„ Advance ..	100	0	0	„ Subscriptions ..	4,129	4	0
„ Transfer ..	500	0	0	„ Contribution, U. of Calcutta ..	300	0	0
„ Contingencies ..	62	6	0	„ Indian Inst. of Sc., Bangalore ..	300	0	0
„ Postage ..	153	10	0	„ U. of Lucknow ..	100	0	0
„ Stationery ..	32	4	0	„ U. of Madras ..	250	0	0
„ Balance ..	16,525	10	2	„ U. of Mysore ..	100	0	0
				„ U. of Punjab ..	300	0	0
				„ U. of Bombay ..	500	0	0
				„ His Excellency the Governor of Bengal ..	500	0	0
				„ Asiatic Soc. of Bengal ..	800	0	0
				„ The Local Sec., Lahore Session, by sale proceeds of Tickets ..	2,443	0	0
TOTAL RS. ..	17,647	2	2	TOTAL RS. ..	17,647	2	2

NOTE.—The estimated liabilities in respect of printing and distribution of the Proceedings for 1927 amount to Rs. 3,179-10-0.

Sd. BAINI PRASHAD,
Honorary Treasurer,
Asiatic Society of Bengal.

II.

Indian Science Congress, Session 1928, Calcutta.

Statement of Local Accounts.

Receipts.	Rs. As. P.	Expenditure.	Rs. As. P.	Rs. As. P.	Rs. As. P.
To amount realised by subscription including Rs. 300 realised towards accommodation ..	10,027 0 0	*Guide Book* :—			
		Remuneration to Editors ..	250 0 0		
		Cost of Printing 1,000 copies of Guide Book, with cost of blocks ..	1,500 7 0		
		Other petty charges	28 15 3		
				1,779 6 3	
		Less realised as Advt. Charges ..	1,040 0 0		
		Less Sale of Guide Book ..	66 0 0		
				1,106 0 0	673 6 3
		Public Dinner :—			
		Caterers Charges ..	506 0 0		
		Hiring of furniture, etc. ..	45 0 0		
				551 0 0	
		Less realised ..		295 0 0	
					256 0 0

Carried over ..	10,027 0 0			

Steamer Trip and Local Committee "At Home" :—			
Port Commr. for two Steamers hired for the purpose ..	..	200 0 0	
Caterer's Charges ..	..	650 0 0	
Hiring of Furniture	..	97 8 0	
Baksis, etc. ..	..	22 0 0	969 8 0
Bolepur Excursion :—			
E.I. Ry. for special train ..	759 8 0		
Caterer's Charges ..	240 0 0		
Petty Expenses ..	14 5 6	1,013 13 6	
Less realised by sale of tickets and refreshment charges	..	975 2 0	38 11 6
Musical Soiree :—			
Sangit Sangha ..	..	121 12 0	
Harold and Co. for Piano ..	..	25 0 0	
Albert Hall rent, etc.	..	52 0 0	
Baksis ..	..	7 0 0	
Taxi Hire, etc. ..	..	9 6 0	215 2 0
Carried over ..	..	..	2,152 11 9

RECEIPTS.

	Rs.	As.	P.
Brought forward ..	10,027	0	0

EXPENDITURE.

	Rs. As. P.	Rs. As. P.	Rs. As. P.
Brought forward ..			2,152 11 9
University "At Home":—			
Caterer's Charges ..	..	300 0 0	
Hiring of Furniture	..	64 8 0	
			364 8 0
Bus trips:—			
Hiring of 64 buses ..	..		600 0 0
Arrangement for the Congress:—			
Decorators ..	..	1,233 0 0	
Telephone (temporary) ..	..	50 0 0	
Cost of making badges ..	..	133 2 0	
Electric wiring charges ..	..	241 0 0	
Cost of Notice Boards ..	..	75 3 0	
Charges for photographs of the office bearers ..	..	111 0 0	
Hiring of gowns ..	..	15 0 0	
Other miscellaneous charges ..	..	221 9 0	
			2,079 14 0
Residence:—			
Calcutta Hotel ..	..	400 0 0	
Hiring of tents, etc.	..	195 0 0	
			595 0 0

Carried over ..	10,027 0 0	

Exhibition :—			
Total expenses under this head ..	..	41 6 0	
Less Stall Rent realised ..	..	35 0 0	6 6
Publicity :—			
Total expenses under this head ..	..		68 10 9
Local Secretaries Office :—			
Salaries of clerks and wages of bearers and their overtime charges, etc. ..	..	563 4 6	
Stationery ..	..	57 0 6	
Postage and Telegraphs and Bank Charges ..	..	184 4 6	
Other expenses (including Type-writer Machines, hiring charges and Remunerations paid for closing accounts) ..	..	109 3 0	913 12 6
Carried over ..	..	..	6,780 14 3

Receipts.

		Rs.	As.	P.
Brought forward	..	10,027	0	0
Total Rs.	..	10,027	0	0

Expenditure.

		Rs.	As.	P.	Rs.	As.	P.	Rs.	As.	P.
Brought forward	..							6,780	14	3
Printing and distribution of programmes, etc :—										
Total expenses under this head	..	..						704	9	0
Volunteers expenses and contingencies :—										
Charges incurred through volunteers	..	..			120	3	0			
Contingent charges (conveyance, etc.)		..			182	4	6			
								302	7	6
Excess of Receipts over Expenditure		..						2,239	1	3
Total Rs.	..	..			..			10,027	0	0

N.B.—A cheque for Rupees Two Thousand two hundred and thirty nine anna one and pies three being the balance of amount in the hands of the Honorary Treasurer was forwarded on 6th August, 1928, to the General Secretary, Asiatic Society of Bengal as per Resolution of the Local Committee of the 25th July, 1928.

Examined and Found Correct.

Sd S. N. Mukerjee,
Chartered Accountant,
Hony. Auditor.

Calcutta :—Published by the Asiatic Society of Bengal, and printed by P. Knight, Baptist Mission Press.

Date of issue.	Date of issue.	Date of issue.
21.5.46		
18-7-47		
9.7.4[illegible]		
31.12.?7		
30.6.58		
30.11.60		
14.2.61		
22/11/62		